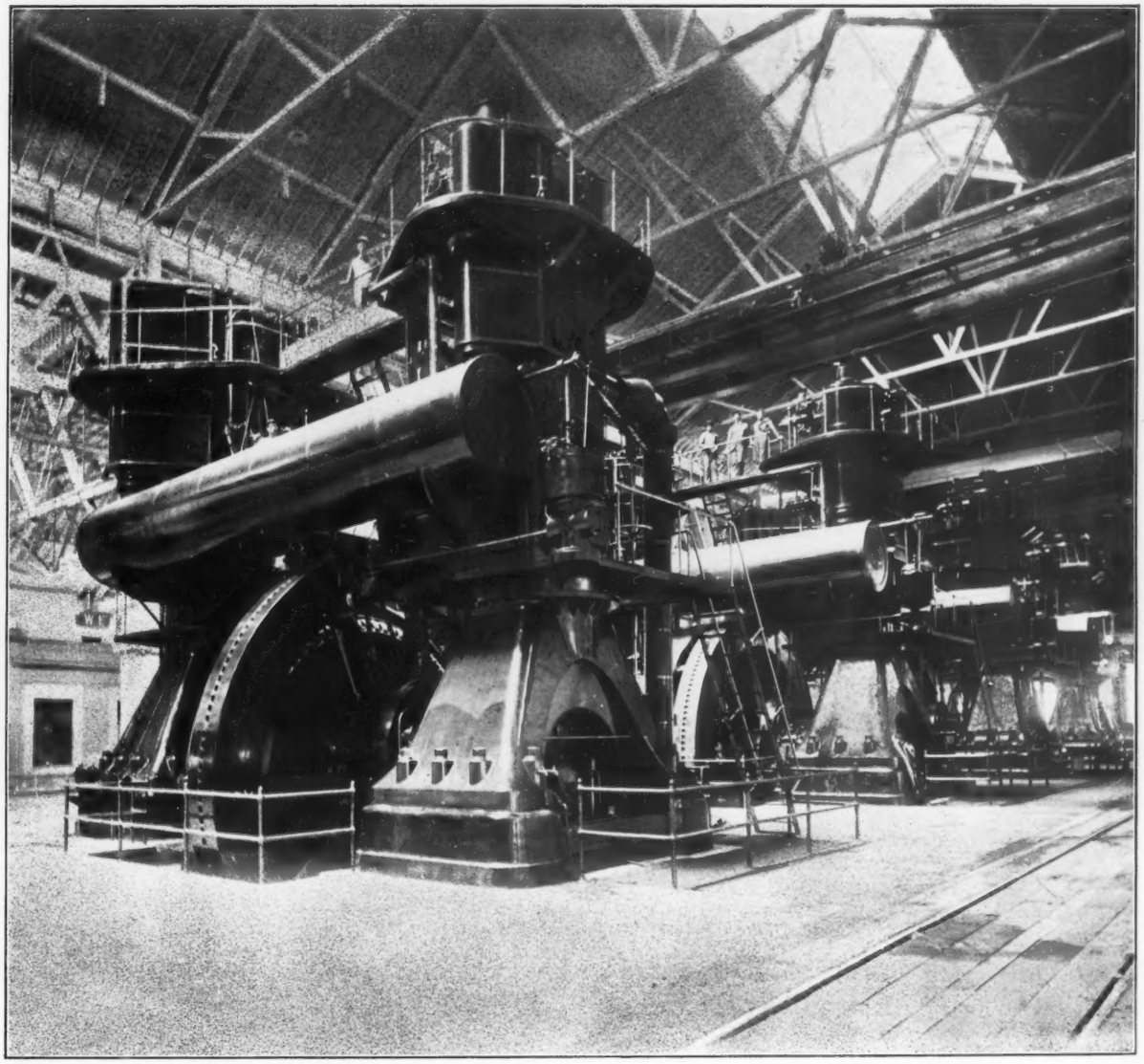
READING ROOM
PUBLIC LIBRARY.

FIFTY CENTS A YEAR

FIVE CENTS A COPY

THE PRACTICAL ENGINEER

VOL. VIII. Philadelphia, November, 1904 No. 10



Four 3000 Horse-Power Vertical Cross-Compound Engines installed in the Service Power Plant, St. Louis Exposition.

Published Monthly at 46 N. 12th St., Philadelphia

For Engineers and Engineers only

Red Label for Leather. Green Label for Rubber.

TRY TO FORGET

THE WORD

"STEPHENSON"

IN CONNECTION WITH

BELT DRESSING

and see how you succeed.

You will find that the rememberance–
like the goods–lasts a long while.

STEPHENSON MFG. CO.

ALBANY, N. Y.

AFTER-THOUGHT

Your local dealer, if he deserves ANY of your patronage, will sell you as little as a pound stick to try. If he throws you down, give US his name in confidence.

FREE SAMPLE OF US BY MAIL, FOR THE ASKING

FREE

TO ANY ENGINEER

A Tabor, Crosby or American-Thompson **INDICATOR**

And also 500 other things including every article, tool or device an engineer may want.

These are give free for coupons which come with every pound of our soft and sheet, and every inch of our metallic packing.

Packings For Every Purpose

and which are guaranteed superior to any other made. Engineer's Catalogue is sent to those who ask for it.

FRANCE PACKING CO., Inc.

6514 State Street, Tacony, Philadelphia, Pa.

MANUFACTURERS OF THE FAMOUS

"Steam Stopper," Brands of Metallic, Fibrous and Sheet Packing.

COUPON 000075

This Coupon represents a ONE POUND PURCHASE
Five of these coupons are equivalent to one certificate and are redeemable according to our premium list at any of our stores.
France Packing Co., Inc.
Headquarters
Tacony, Philadelphia, Pa.

CUT OUT AND SAVE THIS ONE AS A STARTER

France Packings have been on the market for years and are used on some of the largest engines and in the largest plants in the world.

FOR FREE PREMIUM LIST FILL OUT AND MAIL US THE BLANK BELOW.

TEAR OFF HERE

FRANCE PACKING CO., Date_____1904

6514 State St., Tacony, Philadelphia, Pa.,

Gentlemen:—Kindly send me premium list and full particulars regarding the indicators and other articles that you are giving to engineers.

My name is _____

My address is _____

(Give complete address)

I am employed by _____

RAINBOW PACKING

Do Not Be Deceived

"Just as Good" Packings
Are Good for Nothing

RAINBOW PACKING HAS NO RIVAL

Ask for RAINBOW and be sure you get it.

Look for the Diamonds with the word RAINBOW within.

THE ENGINEER'S FRIEND

Can't blow Rainbow out.

Will hold the highest pressure.

Durable
Effective
Economical
Reliable

You Are Sure of TIGHT JOINTS, if You Use RAINBOW PACKING.

Don't be Bamboozled into Using Cheap Imitations

MANUFACTURED, PATENTED AND COPYRIGHTED EXCLUSIVELY BY

The Peerless Rubber Manufacturing Company

16 WARREN STREET, NEW YORK

16-24 Woodward Ave., Detroit, Mich.
Cor. Common and Tchoupitoulas Streets, New Orleans, La.
210-214 N. Third St., St. Louis, Mo.
1218 Farnum St., Omaha, Neb.
202-210 S. Water St., Chicago, Ill.
634 Smithfield St., Pittsburg, Pa.
1601 to 1615 17th St. Denver Col.

220 South Fifth St., Philadelphia, Pa.
17-23 Beale, St. and 18-24 Main St., San Francisco, Cal.
1221-1223 Union Avenue, Kansas City, Mo.
709-711 Austin Ave., Waco, Texas.
51-55 N. College St., Charlotte, N. C.
Cor. Ninth and Cary Sts., Richmond, Va.
20th St. and Railroad Ave. Birmingham, Ala.

The
Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power and to the interests of stationary engineers

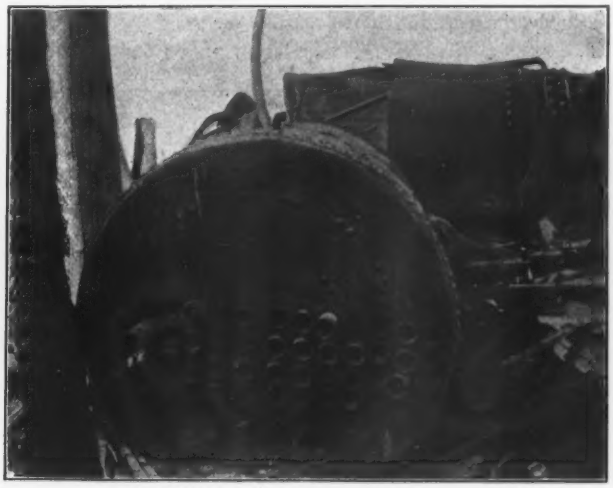
VOL. VIII PHILADELPHIA, NOVEMBER, 1904. No. 10.

EXPLOSION OF A TUBULAR BOILER

The Plant of the Franklin Iron Works at Port Carbon, Pa., Almost Entirely Destroyed.

The Franklin Iron Works at Port Carbon, Pa., was almost wiped out of existence shortly before 11 o'clock on the evening of October 1st, by the explosion of the boiler which furnished power for the plant. The explosion is said to have been the most terrific that has ever taken place in that vicinity. It killed the fireman, William Kane, shattered almost every building on the site, leveled the walls of the engine and boiler house, forge shop and machine shop and damaged the walls of the moulding shop, pattern shop and several old buildings used for a storehouse for patterns.

View No. 1. General view of the Franklin Iron Works after the explosion.



View No. 2. Front of exploded boiler showing where leaky tube had been recently plugged.

The fireman who was in the boiler house when the explosion occurred was instantly killed, his body being found on a pile of coal which is the only thing left to indicate the place where the boiler house once stood. The watchman of the plant narrowly escaped injury. He was seated back of the switchboard, near the dynamo, where the power was generated for the incandescent lights which are used to illuminate Port Carbon's streets. When the crash came, he was knocked down and the roof of the machine shop which collapsed over his head fell within a foot of his prostrate form, narrowly missing him and almost crushing his life out. He was so stunned by the force of the explosion that he was unable to realize for hours whether he was dead or alive.

There are about a dozen buildings in the plant and all of these were built almost directly around the boiler house. The moulding and machine shops are the largest buildings and are situated on the north side. The pattern shop is still further north, the boiler house is in the centre, the office on the east and the storehouse for patterns on the south side between the boiler house and the road.

When the explosion occurred, the dome of the boiler, weighing fully 500 pounds, was blown over the office building and into a yard of a residence nearby, 300 feet to the eastward. In falling, the heavy iron broke a section of the front fence

into kindling wood. Several of the plates, which were part of the boiler shell, were blown in the opposite direction, taking off a portion of the roof of the storehouse, knocking down a tree standing in front of the building, which was carried across

View No. 3. Looking toward the Machine Shop from the spot where the firemen was killed.

the road and landed about 450 feet from its starting point in a flat grass plot. The entire portion of the boiler that remained, which consisted of the ends and the twisted tubes, was lifted from its foundation and carried bodily about thirty feet. A telegraph pole and post against which it was blown were the only things that prevented it from being carried across the road. The cast iron plate upon which the stack rested, and which was located at the rear of the boiler, was peculiarly torn up and blown across the road.

The bricks, of which the foundation of the boiler was built,

View No. 4. Other side of Machine Shop showing reactive force in that direction.

were blown into the walls of the surrounding buildings. In many cases they were driven into the weather boards like so much solid shot and one wall alone, that of the side of the storehouse, was struck by no less than 31 bricks, each of which put a hole in the boards. One of the bricks passed through the wall of a residence which is located about 300 yards away. In fact, so great was the explosion that it was heard in the surrounding towns three to five miles away.

The entire upper end of the machine shop for a distance of fifty or sixty feet was blown away. The section below where the boiler house stood is still standing, to which fact the watchman owes his life, but it is in such bad condition that it must be torn down. The moulding shop, which is built of heavy stone, escaped damage, although the walls are cracked in several places. All the buildings have a peculiar looking appearance, having been virtually painted by the mud in the boiler.

That the loss of life was not greater is fortunately due to the fact that the explosion occurred at night, for had it occurred during working hours, a large number of men working in the machine shop would have undoubtedly been killed, not to mention the many other possibilities of death due to flying bricks. Another singular thing was that while most of the buildings destroyed were composed of wood, there were no signs of fire, the hot coal doing no damage.

View No. 5. Side view of exploded boiler taken from the Road.

The exact cause of the explosion is unknown, but as the boiler was one that had been in continual use for over twenty years, it was said to have been known to be defective. It was certainly not due to low water, as the explosion occurred shortly after the fireman filled his boiler with water preparatory to cleaning and there was certainly plenty of water in the boiler, as the surrounding buildings show.

The boiler was of the tubular type with single riveted girth seams and double riveted longitudinal seams, and was rated at 65 horse power. It was 60 inches in diameter and 16 feet long and contained 80 tubes, 2¾ inches in diameter. The thickness of the shell varied from ¼ to ⅜ inch thick, but in places it was very badly pitted and showed undeniable signs of weakness. The braces, which were originally made of 1¼-inch iron, were in some places reduced to less than 1 inch. The pressure carried on the boiler was usually about 70 pounds, the safety salve being set to blow off at 80 pounds.

There had been a slight accident to the boiler six weeks previous to the time of the explosion, but this was repaired, although it was said that the fireman always considered the boiler unsafe. While nobody around the plant is willing to accuse the proprietor of any negligence as regards the proper

care or repair of the boiler, it merely represents one of those cases where, because a plant has run twenty years successfully, it is supposed to run that many more years without any increased attention or inspection.

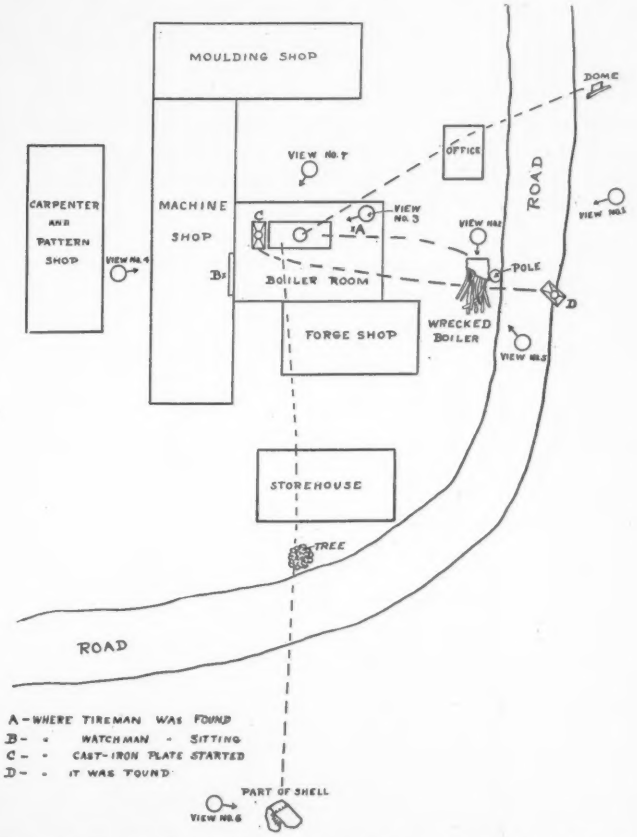
View No. 6. Part of Shell lying 450 feet from the starting point.

It seems impossible in looking over the ruins that one boiler of 65 horse power could do so much damage. A load of dynamite could not have been more destructive, but when the amount of stored energy that the boiler contained is calculated, the power of dynamite vanishes almost into second place as compared with it. The boiler, by calculation, approximately contained about 850 feet of heating surface and 30 square feet of grate surface. It weighed about 9500 pounds and contained nearly its own weight in water, while the weight of the steam, when under a pressure of 75 pounds per square inch, weighs but 21 pounds. The energy that was stored in

View No. 7. Remaining portion of Machine Shop showing brick wall to which the watchman owes his life.

the boiler was equivalent to 52,000,000 foot pounds, of which but 4 per cent. was in the steam, and this would be enough to drive the boiler one mile into the air with an initial velocity of nearly 600 feet per second. Immediately upon the bursting of the boiler, this energy is not in such shape as to be instantaneously available, as the bursting pieces cause it to be used in different directions. When one or more portions of a boiler have been separated from the rest and have been lifted and set in motion by the pressure, it is easy to conceive how the quantity of steam behind them, which is given off from a large body of water, at a high temperature, can propel them to a great distance. The tearing up of a boiler on explosion, although rapid, is not instantaneous, and the somewhat gradual development of the force stored up in the highly heated water keeps up a continuous pressure behind the separating pieces, which is better calculated to hurl them a great distance than a force acting instantaneously and suddenly dissipated.

The plan of the Franklin Iron Works is shown in the ac-



Plan of the Franklin Iron Works showing the path of the exploded boiler and pieces and the positions from which views were taken.

companying diagram. The dotted lines represent the course of the pieces, part of the shell flying one direction, the steam dome flying another direction, while the boiler is turned around as shown. The cast iron base plate C, on which the wrought iron chimney stood, took the peculiar path from C to D. The place marked A was where the fireman stood when he was killed, and B represents where the watchman was sitting behind the switchboard.

On the plan, the different positions from which the accompanying views were taken are shown. View No. 1 is a general view of the devastated buildings taken from across the road, the level space being where the machine shop, boiler shop and forge shop once stood. View No. 2 was taken looking in at the front of the boiler and shows the largest part of

the boiler that remained intact. In the upper row of tubes can be seen where a leaky tube has been plugged. View No. 3 was taken from the spot where the fireman lost his life, the boiler being originally located where the grate bars are lying. Part of the demolished machine shop is shown in the rear. View No. 4 was taken on the other side of the machine shop looking toward the boiler room and office, and shows the reactive force in that direction. View No. 5 is the side and rear view of the boiler taken from the road. Most of the tubes are still hanging on to the rear tube sheet, while the others are smashed and bent. The boiler braces can be seen attached to the tube sheet pointing skyward. View No. 6 is a view of the part of the shell which was blown 450 feet away. It evidently represents the lower and rear part of the boiler shell, as the blow-off pipe was apparently connected to it. View No. 7 shows the remaining portion of the machine shop and the brick wall to which the watchman owes his life. The general white appearance of all the buildings and machinery is due to the mud in the boiler which was thrown in all directions by the explosion.

THE ELECTRIC STORAGE BATTERY

Use and Care Necessary to Produce the Best Results

In the earlier days of engineering when storage batteries were first used, nothing gave the attending engineer such trouble as did the storage battery room, and many were the hard things said about these nasty smelling liquid electricity storehouses. There is not a piece of apparatus used in engineering that can be said to be ideal and whenever a list of advantages of a machine or piece of apparatus is mentioned, there can always be presented a list of disadvantages, especially in a comparative degree. Take the reciprocating engine; many as are its advantages, numerous disadvantages can easily be thought of; the same is true of the steam turbine, the water-tube boiler, the fire-tube boiler, and so on all along the line, but with all their faults, we like them still and the same is true of the storage battery.

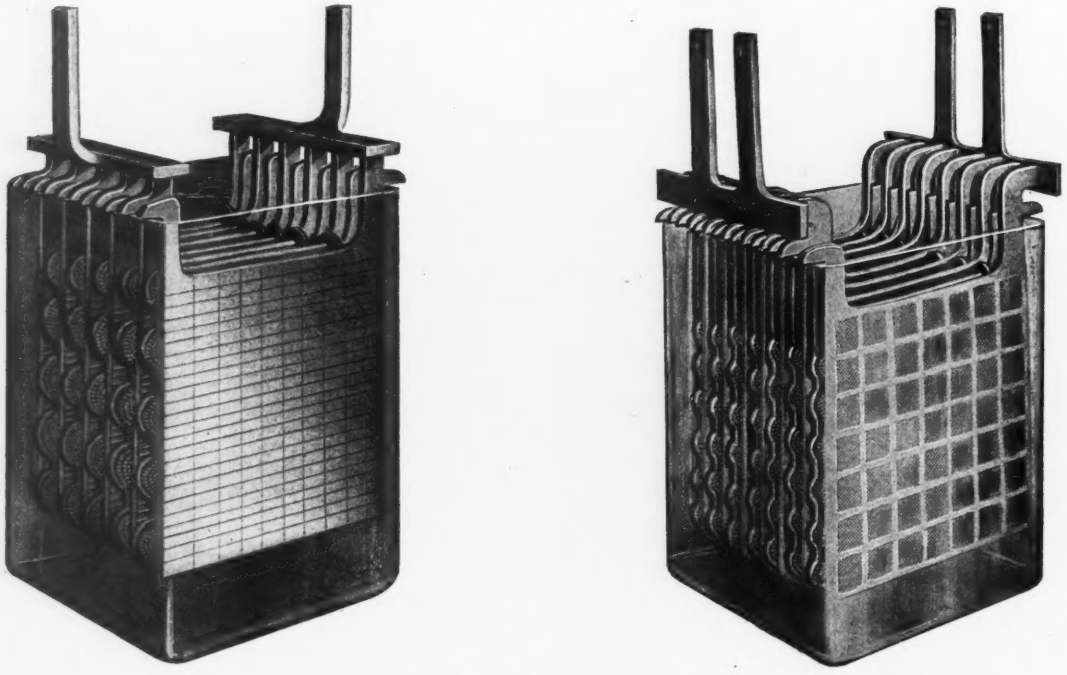


Fig. 1. Types of Chloride Cells.

There are two cases in which the use of the storage battery has come to be of the highest benefit in spite of its numerous disadvantages. The first is to take care of light loads, allowing the moving machinery to shut down and the boilers to be put out of commission as is often done at many plants in the summer, and the second is to take care of what is called the peak of the load. In the first case, the expense of running a power plant on light loads is excessive, so that the doing away with the necessary expense at such times will often result in great saving by using the storage battery. In the second case, in almost no electrical plant is the amount of power used uniform. In lighting work there is a variation, something like that shown in the diagram, Fig. 2, where during the hours of from four to six or eight comes a very heavy load. The storage battery can be used to great advantage in supplying the power represented by the upper part of this curve, they being charged while the load on the dynamos is light, and used in parallel with the generators so as to take a part of the load between the hours when the "peak" occurs. In this way the boilers, engines and dynamos are able to work at a more uni-

form load and therefore they run more economically than they otherwise would.

The principal troubles of storage cells are short circuiting, buckling and sulphating, weakened electrolyte and worn-out plates. Short circuits are usually caused by buckling of the plates, or by the dropping out of portions of active materials of the plate which in time form between the positive and negative plates a connection which causes loss of charge and destruction of the plate, if not noticed. It can be caused by the sediment in the bottom of the jar or tank. A buckled plate is usually caused by a continued excessive overcharge, or a heavy discharge. To assist in preventing it, the plates are separated by glass or rubber distance pieces. If the plates are not badly damaged by buckling, they can be driven apart by a wedge and operated, but when they are burned together, the plates must be repaired before again using. Sulphating is caused by carrying the discharge of the battery too far, or letting it stand too long without recharging. This is remedied by constant charging.

Short circuiting may also occur from sediment in the bottom of the cell. The depth of this sediment usually increases with the age of the cell, until the bottoms of the plate are submerged in it. This will either completely short circuit the cell, or will cause it to rapidly deteriorate, and the proper remedy is to draw off the acid and remove the sediment either by washing or scraping it out. A source of trouble and a cause of much expense is the wearing out of the plates. This always happens to every plate after being in use a certain length of time, the positive usually being the one to wear out first. This trouble can generally be found by noting the voltage of discharge or charge.

The fact that many of these troubles are frequent has not interfered with the use of these batteries, as with careful attention and constant repairs many of the inherent defects are so lessened as to make them as reliable as any other piece of mechanism which requires attention, and which will also act mean and spiteful if not properly treated.

In the care of cells, the frequent use of a voltmeter and hydrometer is necessary, as the greater part of the troubles found in storage cells can be attributed to the improper voltage or a wrong specific gravity. The voltmeter should be connected in succession to each cell of a battery and the readings compared to see if they are uniform, the cells giving low reading requiring attention. The hydrometer gives the density or specific gravity of the solution. The regular use of these two instruments, a careful attention to the discharge rate, regular inspection of the cells, and the making good of water lost by evaporation, so as to keep the tops of the plates always covered, constitute the most vital points connected with the use of the storage battery.

There are three ways in which a battery may be charged: at constant voltage, at constant current, or at constant wattage, the most usual method being that of charging at constant current. This is done by regulating the voltage of the charging current so that the proper current will flow through the cells, the proper charging current being one-eighth the capacity of the cell for an eight hour discharge. If a cell was rated at 2000 ampere hours for an eight hour discharge, then the proper charging current would be 250 amperes.

Before going further, it may be well to describe briefly the storage battery as it is made and used in practice. The type in most general use is known as the chloride cell, manufactured by the Electric Storage Battery Co., and shown in Fig. 1. It consists of two or more lead plates suspended in sulphuric acid and derives its name from the fact that lead chloride is used as the active material between the leaden bars that go to make up the body of the plate. These plates are then suspended in a bath of zinc chloride, together with a zinc plate, with the resulting formation of zinc chloride and pure lead, instead of the lead chloride. The zinc chloride dissolves away and leaves the active material in the form of a finely divided or spony lead. The object of securing this spongy form of lead is to present as much surface as possible to the action of the sulphuric acid in the cell. To form positive plates they are taken and suspended in dilute sulphuric acid, and a current sent through them. The positive plates become coated with a reddish-brown substance, which is known as peroxide of lead. Hydrogen bubbles collecting on the negative plate attack any oxide that may have remained on it and leave a clean surface of lead. After the plates are charged, they are discharged, and in order that the oxidation of the positive plates should go further, they are charged and discharged again. As this peroxide is the active material of the cell, the amount of it produced determines the capacity of the cell; therefore, the plates are alternately charged and discharged, so that the layer of lead which becomes oxidized during the

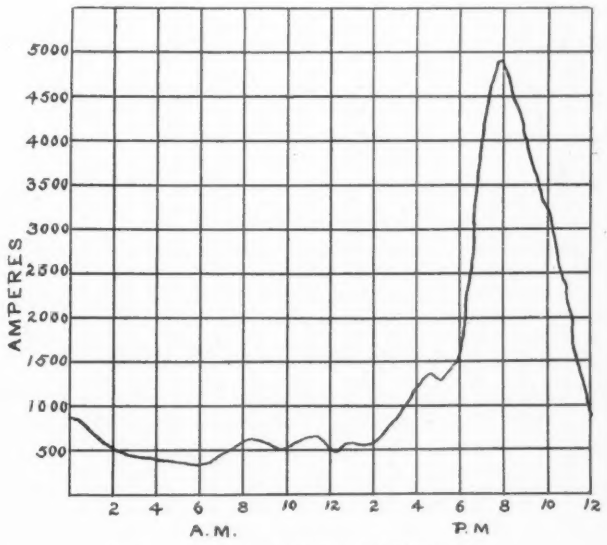


Fig. 2. General Variation of Lighting Load.

charge may be as deep as possible. There is a limit to the depth of this peroxide, beyond which the chemical action will not penetrate, and when this is reached the forming process is stopped. The peroxide plate, which is reddish in color, is the plate from which current flows during discharge and is called the positive plate. The grey colored plate is the one toward which current flows during discharge and is consequently called the negative plate. In making up a storage cell, a negative plate is used on the outside, then a positive plate, then a negative, and so on, there always being one more negative than positive plates. All the negative plates are connected together with a lead strip and similarly all the positive plates. Each of the plates is separated from the other by a space about ⅛ of an inch wide, which is filled with dilute sulphuric acid.

After the completely formed positive and negative plates are put in a jar or tank with sulphuric acid and are electrically connected so that current flows from them, the plates are chemically changed. The red peroxide on the positive plate is changed to lead sulphate and the pure spongy lead on the negative plate is also changed to lead sulphate. This is called sulphating of the cell and the discharge should never be allowed to go below a certain voltage in order to prevent injury from the plates due to this cause.

When the cells are recharged by sending the current through the cell in the reverse direction, the sulphate of lead on the positive plate is again changed to peroxide of lead and the sulphate of lead on the negative plate is changed to metallic lead, and with each charge and discharge of the cell these chemical actions take place.

When a cell is completely charged, large amounts of sulphuric acid gas are given off. The positive plate will assume a dark chocolate-brown color and the negative plates will have a greyish or slate color. When the cells are discharged, the color of the positive plate will change to a yellowish-brown, while the negative will darken considerably.

The looks of the battery have, however, very little to do in determining when the charge or discharge of a battery should be stopped, the voltage and specific gravity being the determining factors. In general practice, a battery may be

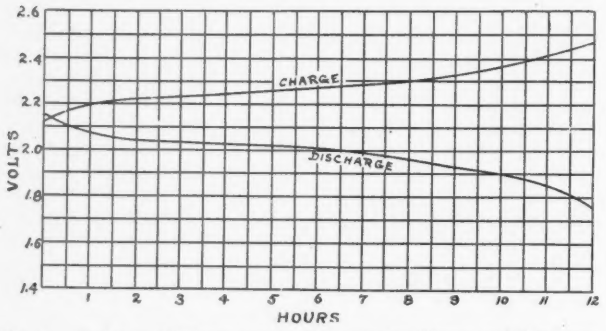


Fig. 3. Variation of Electro-motive Force during Charge and Discharge.

said to be fully charged when the voltage does not increase for at least fifteen minutes with a constant current flowing through it. This voltage will be the maximum as will also be the specific gravity of the cell. The effect of charging a cell is to increase its specific gravity, and when this is the maximum, the cell may be said to be fully charged. The normal charging voltage is usually 2.5 when the battery is new, and 2.4 after it has aged, when the temperature of the electrolyte is about 70 degrees.

The voltage of a cell will be about 2.2 when fully charged and should never be allowed to fall below a voltage of 1.7. When a cell has reached this point, any further discharge will cause a very rapid falling off in the voltage and when it has reached this point, not only should it be no longer used, but it should be immediately recharged. A battery that is left standing when it is discharged will deteriorate very rapidly, the above-mentioned sulphating doing the damage. The variation of the electro-motive force during the time of charge and discharge can be shown by the accompanying diagram, Fig. 3, the curve showing the rise and fall of the voltage of each cell compared with the number of hours of charge or discharge.

The specific gravity also rises and falls as the cell is charged and discharged. This variation should not in general exceed 35 points. That is, if the specific gravity of a cell be 1.21 when it is fully charged, it should not be less than 1.175 when it is fully discharged.

Owing to the fact that the electro-motive force of a cell increases with the charge and decreases with the discharge, it is necessary to have special arrangements by which a dynamo while supplying lights may charge a battery of cells, and by which the electro-motive force of a set of electric cells may be kept constant while they are supplying lamps. Suppose on a 110-volt circuit we have the usual number of 60 cells. When fully charged, as each cell has an electro-motive force of 2.2 volts, the total electro-motive force of the 60 cells is 132 volts. As the charging goes on and as it is desired to run 110-volt lamps and charge the cells at the same time, it is, of course, impossible to raise the voltage of the lighting dynamo, so an auxiliary dynamo or booster is employed, its armature being put in series with the cells, and its field varied by its rheostat so as to give enough additional volts for charging at the proper rate. The general arrangement for doing this is shown in Fig. 4. B is the booster and R is the rheostat, V is a voltmeter and A an ammeter, so arranged that its needle stands at zero when no current is passing through it, moving to one side when the charging current is passing through it, and to opposite side for a discharge current. K represents the main battery and H the end cell switch which throws the cells in or out. S is a double throw switch, which, in one position, connects the batteries to the lamps to be supplied with current, and in the other position, connects it to the dynamo for charging. E is a switch for connecting the voltmeter, so as to give the voltage of the battery, the line, the charging dynamo and booster respectively. When nearly discharged, as each cell would give out 1.8 volts, the combined voltage would be 108 volts, or just what is desired. When the cells are fully charged, a sufficient number must be switched out of circuit to bring the voltage down to 110 volts. As the cells discharge and their electro-motive force falls, these cells are switched back into the circuit one at a time till at the end of the discharge they are all in circuit. The arrangement for doing this is known as the end cell switch. It consists of a number of contact pieces which lead off from a number of the batteries to a double set of switch contacts, which are connected to the distributing bar, which connects with the switchboard. The brush contacts are mounted and driven by a worm which is usually operated by a motor, but which can be moved by hand.

The arrangement for charging is somewhat more complicated. As the electro-motive force of the cells and the booster rise, O is an automatic circuit breaker which will operate if too much current is taken from the batteries, and C is a circuit breaker which will open the circuit if the charging current becomes less than a certain value. This last is necessary if a compound wound dynamo is used, in order to protect the dynamo from having a reverse current sent through it from the battery if by accident it was slowed down or stopped before the charging switch was opened.

Storage batteries are rated according to their capacity, the usual unit used for this purpose being the ampere-hour. A cell that has a capacity of 500 ampere-hours is one which, when discharged at its normal rate, gives out a certain number of amperes, so that the product of the current times the

number of hours gives the capacity of a cell; that is, if a cell gave out 50 amperes for 10 hours, without carrying the voltage below 1.8, the cell would be said to have a capacity of 500 ampere-hours. When a booster is not available when charging the cells from a dynamo whose voltage cannot be raised, a method often resorted to is to split the battery in half and charge each half separately, throwing resistance into the circuit in order to cut down the voltage to the required amount. Fig. 5 shows a circuit of this kind in which BB are the two halves of the battery, O is the overload switch, C the underload switch, R the rheostat, A the ammeter, which shows both the charge and discharge current, G is the generator, L the lamp circuit and S and J the double pole double throw switches. When S is shut one way and switch T is thrown to the left, the battery is charging. If S is shut the other way and switch T thrown to the right, the battery will discharge in series, the connection being so arranged that the underload switch is cut out.

As a storage battery must be charged with direct current, when used in connection with an alternating system, a rotary transformer must be inserted to straighten out the current. As usually connected, an induction motor is connected to a generator which charges the batteries in connection with a booster set.

Storage batteries are extensively used for train lighting in connection with a generator and booster. This system is one in which the load on the generator is kept constant by the

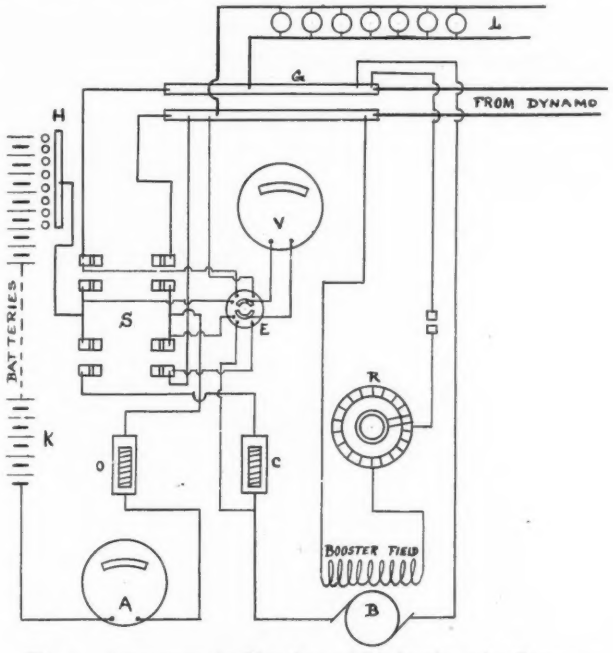


Fig. 4. Arrangement for Charging and Discharging using Booster.

automatic distribution of its output through the medium of the counter electro-motive force booster to the electric lights and the batteries, according to requirements. If the number of lights burning require the total energy of the generator, the batteries will receive no charge. If the number of lights burning is equal to only one-half the capacity of the generator, the other half of the capacity will go into the batteries, the voltage of the generator remaining constant. The booster set automatically furnishes what additional voltage is necessary to charge the batteries. The batteries supply the lights when the train is at rest. There are many other modifications of the booster system in connection with the storage battery, such as with a 500-volt system, a three-wire system, etc.

A few points which must be followed to get the best results are as follows:

Accessibility is one of the main objects in the location of the batteries, as they must be inspected regularly. The bolts and

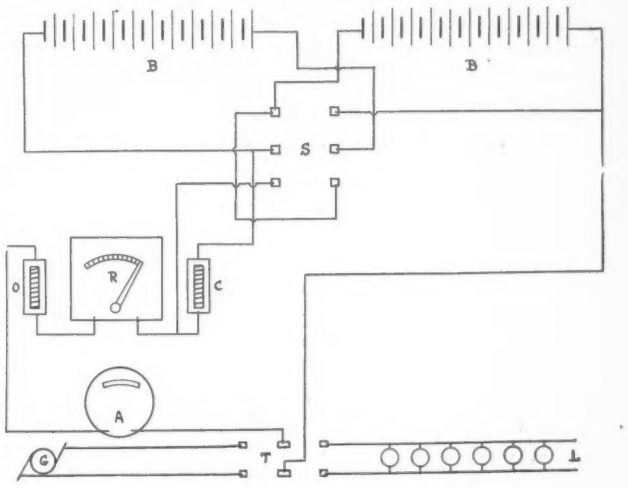


Fig. 5. Split Battery Arrangement for Charging Storage Cells.

nuts between the batteries must be tight. All contacts should be kept clean and bright with crocus cloth and the moving parts regularly oiled. If the switches are mounted near the acid fumes, the iron parts must be painted with asphaltum paint and the copper and brass work rubbed over with oil or grease to prevent corrosion by the acid trickling down the sides of the cell and for this reason they should be allowed to stand in oil or sawdust. All conductors and connections should be wiped frequently with linseed oil to prevent corrosion.

The specific gravity of the sulphuric acid solution should be about 1.200, and the temperature should never be allowed to exceed 100 degrees. The plates should be all covered by the electrolyte and as soon as the electrolyte is put in the cells, they should be immediately charged. Charging at a higher rate than allowable is worse than over-discharging, the results being buckling or blistering of the elements, owing to the rapid formation of gas and its slow liberation. The effect of over-discharging is to cause sulphating, which increases the internal resistance of the cell and is difficult to get rid of. Frequent small charges and discharges keep the cell in better condition than when left standing for a long period. In adding water or acid to a cell to change its specific gravity, do it after a charge and never during one.

Congratulations.

EDITOR THE PRACTICAL ENGINEER:

I wish to congratulate you on the quality of the paper which you are publishing at the present time. The October number is certainly all right. I do not see how you can publish it for the money.

Stockton, New York. H. J. INGRAM.

SOMETHING ABOUT PLUG COCKS

By W. H. Wakeman.

The common brass plug cock is suitable for use on a gas pipe, or on a pipe through which only cold water circulates, but for places that are subjected to changes of temperature it is far from satisfactory, because expansion and contraction do not affect all of its parts evenly, hence the plug will sometimes "stick" fast in place, making it difficult or impossible to move it when it is necessary to do so. When loosened

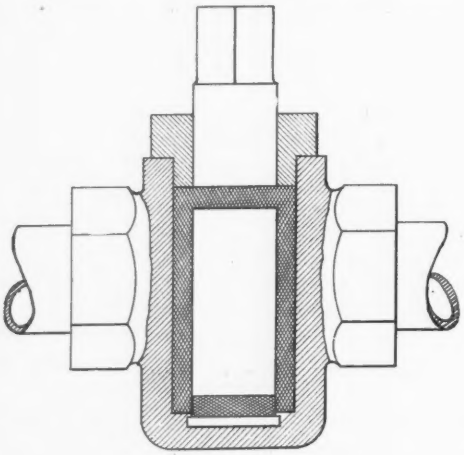


Fig. 1.

enough to prevent this, it will almost always leak around the top and bottom of plug, although it may prevent the passage of anything through the line of pipe to which it is attached.

When the asbestos packed plug cock was put on the market, a new era in this line of work was begun that is heartily appreciated by the majority of engineers and firemen. Fig. 1 illustrates one of these cocks and it will be seen that the lower part of plug does not project through the body of cock, and this design prevents all leakage at this point. The upper part is packed with asbestos to prevent leakage here, and there is a layer of the same material all around the plug which keeps water, steam, air or whatever may be in the pipe line under pressure, from passing the cock.

This design eliminates one of the principal objections to the plain plug cock; namely, the effects of contraction and expansion, for although cold and heat affect metals of all kinds, or at least all that are in common use, the asbestos packing put in by means of hydraulic pressure, compensates for the changes. The plug and stuffing box gland are so made that the former can only be turned through one-quarter revolution, but this, of course, gives full opening, or closes it completely, according to the position of plug. Fig. 2 shows the same kind of a cock except that it is for use in place of an ell instead of on a straight line of pipe; or in other words, it is an angle cock.

The argument frequently carried on by engineers concerning the best way to connect a globe valve, does not apply here, as either of the foregoing may be connected so that steam or water will pass through them in either direction according to the most convenient plan.

When we consider that it requires only one-quarter revolution of the plug to open or close these cocks, it is plain that when a column of water is passing through one of them at a high rate of speed, the momentum gained by it is suddenly stopped by a turn of the wrist. If the plug is turned quickly it results in a heavy shock to the pipe, which may cause a weak spot to fail, killing or injuring somebody. In two cases that I recall, men met horrible deaths on account of the failure of blow-off pipes on steam boilers, which allowed steam and hot water to rush into narrow passages from which there was but one way of escape and that was closed by the accidents. The blow-off cocks or valves were opened under pressure, and there is little chance for doubt that they were closed suddenly, causing water hammer, or water ram, strong enough to break the pipes and kill the men. This shows the necessity of closing valves and cocks slowly, when they control water under pressure. Injudicious use of these appliances under low pressure is more destructive than careful use of them under much higher pressure.

Fig. 3 illustrates a large asbestos packed plug cock, fitted with a worm gear operated by means of a hand wheel. This design not only brings great purchase to bear on the plug to open it under heavy pressure, but it insures its slow operation.

As asbestos packed cocks are not satisfactory to some engineers, while others consider them first-class in every respect, a brief notice of different ways of using them will prove interesting. As they are now made so that it is impossible to give the plug a complete revolution, the argument which formerly was indulged in concerning the best way to turn it, is indefinitely postponed.

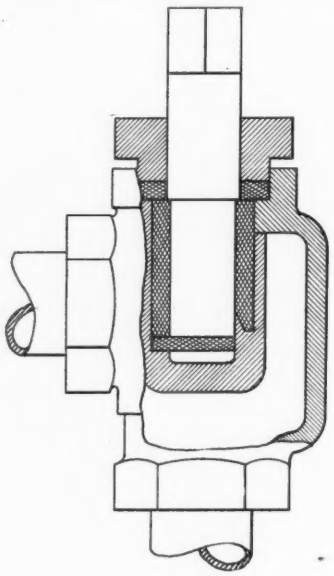


Fig. 2.

If these cocks are opened and closed frequently they will remain tight longer than if left closed long enough to become partly corroded in place, for when they are moved, the smooth

surface essential to a tight fit is destroyed, hence the cock leaks. Where it is not convenient to move them frequently, the plug should be oiled to prevent abrasion or cutting of the surfaces when it is moved. The necessity for this is one reason why the plug should always be located in a vertical position, so the oil will have a chance to work downward where it is wanted. Kerosene oil answers a very good purpose here as it penetrates quickly.

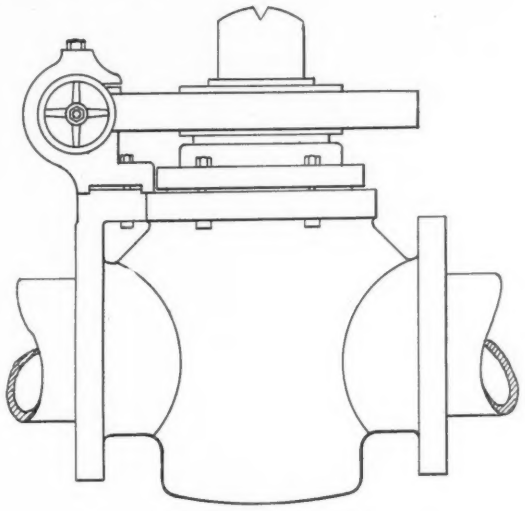


Fig. 3.

In course of time the plug will wear a little, but the judicious use of oil will reduce this to a minimum. An engineer who was troubled by the fact that a plug cock worked hard, bored a hole through the entire length of the plug, cut a thread in the top of it and screwed in a small plug. He takes this out occasionally, fills the hole with cylinder oil and replaces the small plug. The oil works down where it is wanted and lubricates the plug, making it turn easy. The only objection to this plan is that the plug must be taken out to bore the hole, which renders the makers' guarantee null and void, as it cannot be replaced properly without special tools for the purpose.

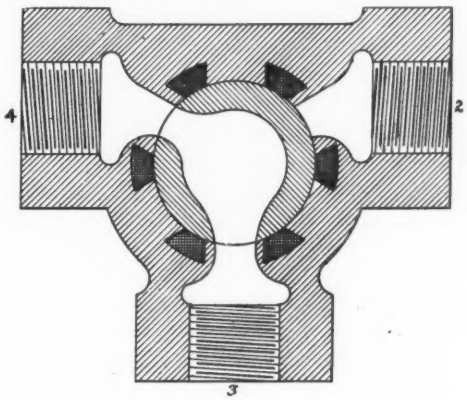


Fig. 5.

Fig. 4 illustrates an improved cock with an adjustable plug. By turning the small plug at the bottom, which is made with a tapering point, the main plug can be expanded, thus compensating for wear. This is also fitted with a stuffing box to prevent leakage around the upper part of plug or stem. If the ordinary asbestos packed cock leaks at this point, the engineer proceeds to screw down the nuts which hold the gland in place, but owing to the hard nature of the asbestos

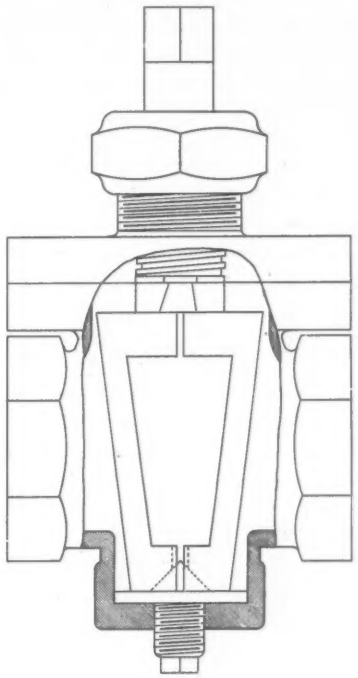


Fig. 4

packing, only a very slight depression of the gland can be allowed. As the nuts are turned too far, the main plug is gripped and either held fast, or it turns so hard that it proves unsatisfactory. The remedy is to turn the nuts only a trifle, then wait to see if the leak has disappeared.

Fig. 5 is a plan view of a three-way asbestos packed plug cock, which may be used as a blow-off cock for two boilers, or fitted to any system of piping where a three-way cock or valve is useful. As shown, the port 2 is open, also 3, therefore if a blow-off pipe entered 2, water from this boiler would go through 3 to the sewer, while 4, which takes the blow-off pipe from another boiler, remains closed. By giving the plug one-quarter revolution to the right, port 2 is closed, 4 is opened and 3 is again opened. See Fig. 6. Ports 2 and 4 can be

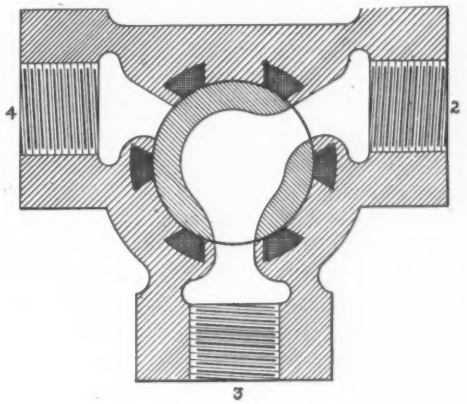


Fig. 6.

opened at the same time, but this is not desirable because it would simply open communication between the two boilers.

By turning the plug to a position midway between the two plans shown in Fig. 5 and 6, all ports are closed, thus making a series of three results that can be secured with one plug cock.

There are several wrong ways, but only one right way to use cocks and valves about a steam plant, and the careful observer is sure to be impressed with the way in which some engineers and firemen find the wrong ones, and failing to discover their mistakes, condemn the fixtures without qualification. While it is not practical to point out all of these mistakes, nearly all of them can be avoided by due consideration of the subject followed by the exercise of good common sense, aided by observation of the experience of others.

Some Things about Horse Power and Compression.

By William Kavanagh.

If an engineer was asked what constituted a horse power, he would in all probability answer the above question by saying "that a horse power was equal to 33,000 pounds raised one foot high in one minute." To the practical engineer, this answer is considered all right but to the layman or one not versed in the science of engineering, it seems altogether unreasonable that a horse should be capable of developing sufficient energy to move such a weight. In fact, there are many engineers who imagine that the horse is actually capable of moving the entire weight above mentioned as a mass and that the weight can be moved by lifting it one foot in one minute. Now, suppose we enter this subject a little more thoroughly and see how it can be done. In English and American practice, a horse is considered capable of raising 33,000 pounds one foot in one minute. At first sight this weight seems entirely out of proportion to the energy of a horse, especially when we consider that 33,000 pounds is equal to 16½ short tons. But if we look at this in another way the comparison between the weight and energy of the horse won't seem so absurd. Suppose we load upon a rolling platform, a truck or wagon for instance, a mass sufficient to require a pull of 550 pounds and the platform is drawn by means of a horse 60 feet in one minute, then the difference between the weight to be moved and the energy of the horse won't appear so great. It is clear that if we load the platform with enough weight to require a pull of 1100 pounds, we must drive the horse 30 feet in one minute to produce the same result. Now, if 2200 pounds, or nearly one long ton, be drawn 15 feet in one minute, we begin to realize more clearly the meaning of the term horse power.

According to Joules' equivalent, one heat unit is capable of developing sufficient energy to raise 772 pounds weight one foot in one minute, so let us see how many heat units will be required to equal the power of one horse. Since one heat unit is capable of raising 772 pounds one foot high in one minute, it follows that if we divide 33,000 by 772 we will obtain 42.74 heat units as the required amount, and if we multiply 42.74 by 60, the number of minutes in one hour, we will obtain the number of heat units that will be required to equal the power of one horse exerted for one hour. Thus, $42.74 \times 60 = 2564.40$ which equals the number of heat units required. Now let us consider a poor grade of fuel costing about $2.50 or $2.75 per ton, delivered at the boiler room. Such a grade of fuel will contain about 9000 heat units per pound and if our engine requires 3 pounds of such fuel per horse power per hour, it follows that 27,000 heat units will be the required number to perform the work of one horse in that time. The lifting power of 27,000 heat units will be $27{,}000 \times 772 = 20{,}844{,}000$ pounds raised one foot in one minute. This is equivalent to the actual work that would be done, providing that all of the heat units were utilized and this is the theoretical value of our fuel. If we divide 27,000 by 2564, cutting out the fraction, we can readily see that our engine is using less than 1-10 of the heat units contained in the given fuel, and as our engine varies in economy, the above fraction will become larger or smaller as the case may be. This loss decreases with the compound engine using coal of the same calorific value. The modern triple expansion engine requires in the neighborhood of about 1½ pounds per horse power per hour.

From the above it appears that in order to realize the greatest amount of work from the steam, it must be used expansively. The steam should be admitted to the cylinder at as high a pressure as possible, the steam ports should be large so as to admit boiler pressure upon piston and the greatest number of useful expansions should be exacted. A portion of the exhaust steam should be compressed so as to fill clearance and insure quite cool running bearings. Some engineers contend that compression is a loss and that their engine runs cooler and more economically without it. The writer is unable to understand how this can be, since the momentum of the reciprocating parts must be brought to rest twice in each revolution and according to well-known laws, the compressed steam will give back precisely the same amount of energy that was required to compress it. The great majority of engines running without compression will have hot crank-pins and bearings unless early admission is resorted to. This in itself is equivalent to compression, with the exception that it is more wasteful and less satisfactory, since compression is a gradual increasing resistance upon the piston while early admission is an immediate one. With respect to the economy of compression, it is apparent that the portion of exhaust steam entrapped to fill the clearance is not required from the boiler. Should we admit steam early without compression it will be seen clearance must be filled at the expense of the coal pile.

Length of Connecting Rod.

The length of a connecting rod is measured from the centre of the cross-head pin to the centre of the crank-pin. For stationary engines, the most usual length of the connecting rod is from 2.5 to 3 times the length of the stroke, but the ratio of length of rod to length of stroke is sometimes as small as 2. and sometimes as large as 3.75, depending on the design of the engines. For ordinary marine engines, the ratio of length of rod to the stroke is generally about 2, but is sometimes as large as 2.5. For the engines of warships, which are required to occupy as small a space as possible, the connecting rod is sometimes only 1.75 times the length of the stroke of the piston. In locomotive engines, the length of the connecting rod is generally about 3 times the stroke of the piston, but sometimes this ratio is as small as 2.7 and in some exceptional cases it is as large as 4.8. In portable engines, 3.5 is a common ratio for the length of the connecting rod to the length of the stroke..

Electricity Accidents.

The following rules have been given to help any person who has been shocked by coming into contact with an electric current whose voltage is deadly:

If you can, shut off current as quickly as possible.

Release injured person from contact with wire.

Be careful to protect yourself from shock.

In releasing injured person, do not touch wire or any part of the person directly.

Don't touch with bare hands; don't use anything made of metal; don't use a moist stick.

If rubber boots and rubber gloves are at hand, stop to put them on.

If not, try to find dry paper or dry board to stand on before touching the injured person.

Covering hands with dry paper is wise.

If wire is lying on top of injured person, flip it off with a stick.

If wire is under person, and you have to lift him, do not grasp or touch his body, take hold only of his clothes.

In electric shocks, the person shocked is generally insensible.

Lay him down and loosen clothing.

If breathing is suspended, artificial respiration must be resorted to.

Burns caused by electric shock can be treated just as burns from fire.

Model System of Piping for a Laundry.

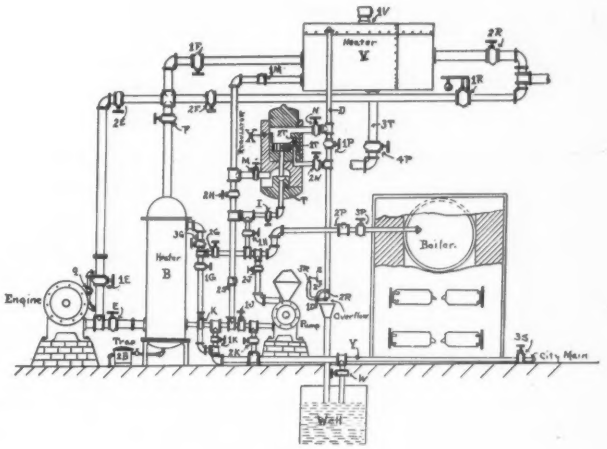
By W. A. Dow.

Editor the Practical Engineer:

It is evident that the designers of small steam plants do not take into consideration the economy or convenience of operation in the future, but simply content themselves by arranging the equipment for the present. They neglect many little improvements which, if taken into consideration, mean dollars for the owner.

In designing a steam plant for furnishing power to a laundry, the units and piping should be so arranged as to give the best results. In the accompanying sketch is shown a steam plant in which the piping is designed properly.

It is so piped that the water passes through a coil in heater B from the city main Y. From heater B it goes through regulator X to heater V. Heater V is placed in the top of the building and its capacity is 3000 gallons. The water is drawn through pipe 3T for washing purposes. The exhaust steam from the engine passes through a large coil in heater V, water being taken from the bottom of the heater B for the boiler feed. The operation of the plant is as follows: By closing valves W, 1K, 2K, 1H, 2H, 2G and 1P, and opening K, 3G, 1G, 1J, 2J, 3P, I and M, the water is forced by city pressure through the coil in heater B through valves 1G, 3G, K, I to the regulator X, under check valve T, raising it up, the water passing through valve M and the check valve 1M to tank V. When the tank V is filled to a danger height, the check valve in top of tank is closed by the pressure, the water enters an overflow pipe D passing through valve N on top of piston 1T. This piston 1T is four times the area of the valve T. Thus the pressure forces the piston down, closing valve T and shuts off the inlet to the tank. The water escapes through port 2T to the lower side of the valve 1P, which is closed. Through valve 2N to overflow pipe back to the well, a small band of iron is made fast to the overflow pipe and hooks downward, as at 2R. Another lever is shaped and pivoted on hook 2R at 1D. This lever is part wood and part brass. The upper end of it has a brass hook, the lower part being also brass. A small wire is connected to a pin on a board made fast to the wall, as at S. Another wire is connected to the end of the lever at 3R. These wires are connected to an electric bell. The water escaping through the overflow pipe forces lever 1D down, making a contact with wire S, through hook Z. This closes the circuit and the bell rings. As soon as the water stops running out onto this lever, the upper end drops down by its weight, opening the circuit, and stops the bell from ringing. This is a tell-tale and prevents a waste of water in case the regulator is out of order. It can be regulated by the man in charge and the regulator cut out by closing valves I and M and opening valve 2H. By closing valves 3S, K, 3G, I, M, 1H, and opening valves 2K, 2J, and 2H, water is taken from the well by the pump and is forced through heater B, to tank V. Boiler feed is taken from heater B, by closing valves 2K, 1K, 3G, 1H and opening valves K, 1J and 2J.



System of Piping for Laundry.

In this case, if the pump is to draw from the well through the heater B, valve 3S must be closed. The engine exhaust enters heater B through valve E, through heater to valves F and 1F to heater V, through heater V and through valve 2R and out the side of the building.

In case the back pressure is more than what the back pressure valve, 1R, is set, the exhaust will by-pass heater V as shown. By closing valves E, F, and opening valves 1E, 2E, exhaust steam by-passes heater B. By opening and closing the different valves, steam can be exhausted from the engine through both heaters or by-pass one or both. The little valve shown at Q, is a check placed in the by-pass pipe which opens downward. This allows the water of condensation in exhaust pipe to escape into heater and be carried off by trap 2B. 2S is a check valve that opens upward and closes downward; 2P is a check in boiler feed-pipe; 1V is a check which allows air to flow into tank.

A mixture of black lead and soap is very good for lubricating tooth gearing.

The Practical Engineer

PUBLISHED ON THE FIRST OF EACH MONTH

L. L. RICE, Proprietor

46 North Twelfth Street Philadelphia, Pa.

The Practical Engineer is devoted to the economical generation and utilization of power for the industries.

Articles upon subjects of interest to engineers, will always receive our very careful attention.

The little things are often most valuable, therefore, we especially solicit short articles on the small problems met with in daily practice. When illustrations are desirable a pencil sketch is sufficient.

Address all Communications and make all Checks, Money Orders and Drafts payable to

The Practical Engineer

46 North Twelfth Street Philadelphia, Pa.

SUBSCRIPTION RATES in the United States, Canada and Mexico, Fifty Cents the year, in advance.

FOREIGN SUBSCRIPTIONS to countries within the Postal Union, postage prepaid, One Dollar the year, in advance.

Entered at Philadelphia Post-office as Second-class Matter.

Size of Reciprocating Engines.

The tendency of modern engineering has been continually in the direction of larger and larger reciprocating engines and dynamos, but at the present time there seems to be a lull in the advance along this line. Engineers who have advocated the erection of very large units were influenced by the economy of steam and the saving in operation which these large units are said to possess. Other than this, every time an enormous engine was installed in a plant, it brought notoriety to the type of engine and the contracting engineers.

A question might here arise as to just what is meant by a large engine. A twentieth-century view of the field would class a 1000 horse power engine as belonging to the large engine class, a 750 horse power engine as belonging to the medium sized class and an engine under 500 horse power would be classed as a small engine. Looking back over the last four years, it is doubtful if this classification could be raised if the trend of the kind of engines shown at the last two great Expositions be taken as a standard. When in 1900, the Exposition at Paris contained many large engines built in Germany, France, Belgium, Switzerland and the United States, it was predicted and in fact promised that, so far as size was concerned, the St. Louis Exposition would outrival the French Exposition. Whether this is so or not, a comparison will show.

Among the largest engines shown at the French Exposition by Germany were three vertical engines and one horizontal engine. The three vertical engines were a compound of 1500 horse power, a triple expansion three-cylinder engine of 2000 horse power and a triple expansion four cylinder engine of 2500 horse power. The horizontal engine was of the triple expansion type, having four cylinders working on two cranks and generated 1900 horse power. The largest Belgium engine was a horizontal tandem-compound of 1000 horse power. Switzerland showed a 1500 horse power engine of the four cylinder triple expansion horizontal type, working with two cranks. Great Britain was represented by a 2400 horse power central valve engine of the Willians type. The United States was represented by a 1500 horse power Allis type of engine. The French engines included a vertical, inclosed engine of 1250 horse power and a single cylinder engine of 1100 horse power. The above engines were the largest shown by the different countries, there being many smaller ones of different design and construction.

At the St. Louis Exposition, the main power plant consists of about twenty reciprocating engines ranging in size from 200 to 5000 horse power. By far the largest engine is the 5000 horse power engine, built by the Allis-Chalmers Co. It is of the right-angle compound type, having two cylinders, the high pressure cylinder being horizontal and the low pressure cylinder being vertical. Next in size to this engine are four 3000 horse power cross-compound engines, erected by the Westinghouse Company. Then comes a 2200 horse power engine of the Hamilton Corliss vertical type. Next in size comes a Buckeye horizontal cross-compound and a French six cylinder quadruple expansion engine, having three cylinders on each shaft. These two engines are 1500 horse power each, the French engine being the largest foreign engine shown. The only other engine above the thousand horse power mark and the only other foreign engine is a horizontal tandem compound engine rated at 1000 horse power. The Willans engine shown at this exhibit is only 900 horse power.

The other engines shown are the Murray single cylinder, Fleming horizontal tandem compound, Buffalo Forge horizontal tandem compound, Skinner single cylinder, Brown vertical cross compound, Lane & Bodley horizontal cross compound and Greenwald horizontal cross compound. These engines range from 900 to 200 horse power.

Comparing the large engines of the two Expositions, there are only six types at St. Louis over 1000 horse power, while in Paris there were twelve engines shown whose rated capacity was over this power.

Neglecting the matter of Expositions, which are said to be the barometer of the times, many engineers favor a greater number of medium-sized engines in preference to a few large ones. One of the chief reasons for this is the immunity from a shut-down. In a plant where 10,000 horse power would

be required, it would be folly to put in only two 5000 horse power units. It would be very much better to put in four 2500 horse power engines or ten 1000 horse power units or a number of different sized engines, depending on the load.

A steam engine is usually the most economical when run at its rated horse power. If run lower, cylinder condensation plays an important part in the lowering of the efficiency, and if run at overload, the steam is not used at its best rate of expansion. With a variable load, the more different units at hand, the more are the economical combinations that can be utilized. If a plant has a very large capacity, then the use of very large engines, such as 5000 horse power would be good engineering practice, if they run satisfactorily.

While comparisons are often odious and very seldom convincing, yet an illustration of the folly of using very large engines is shown by two power plants which are located in one of our large cities. In the one plant, a 5000 kilowatt unit is used for carrying the load at stated intervals during the day. In the other plant a great number of 750 horse power engines have been used. The history of these two plants for the past six months has been as follows: The 5000 kilowatt unit, on account of its large size and perhaps, imperfect design, has broken three valves, the steam line has broken once, it governs poorly and on the whole it has run very unsatisfactorily. As it must be thrown in and out of synchronism with other units, its unwieldiness has caused much trouble, the lamps on the circuit being invariably affected and when the circuit breaker flies out, it often leaves an enormous number of consumers without any power.

On the other hand, in the plant where smaller units are employed, there has been no accident of any kind whatever and besides the greater flexibility of the system, the economy from the coal pile to the switch-board is practically the same in both cases.

Whatever may be the special advantages of using large engines in very large plants, it must not be thought that the installation of a large engine always means an advance in the progress of engineering.

Electricity and the Stationary Engineer.

The influence and importance of the operating stationary engineer in the industrial world are increasing with marked rapidity and it is safe to say that no other trade or profession has risen so rapidly in the esteem and respect of the general public during the past decade.

The factor which has unquestionably contributed most to the sudden advancement of this particular profession has been the advent of electricity and its numerous applications, for without it, the steam engine would have found a much smaller field of usefulness and have undergone a smaller degree of refinement, while the central station electric power and lighting plants would have existed only in theory.

This thought has been brought to mind by the fact that electric traction is now just a quarter of a century in existence. Germany is about to celebrate the twenty-fifth anniversary of the first successful application of electricity as a motive power. The initial experiment, made in the year 1879, consisted of an electric locomotive which ran on an exhibition track at the Berlin Commercial Exposition and at that time it gave little promise of ever having the practical importance which it has since become and it is doubtful whether the great majority of the visitors who saw it there for the first time could have believed that this small piece of exhibition track would have elongated in Germany alone to 3000 miles of trackage, over which 15,000 cars are propelled by electricity daily.

While it was not until 1885 that the first trolley cars were run in Richmond, Va., the United States has outstripped the world in its application of electric traction. Its marvelous adaptation for the propulsion of surface cars has gridironed all our cities and smaller towns. Indeed, no modern invention has been more widely adopted in a similar period of nineteen short years since its introduction. Children of to-day, accustomed as they are to seeing electrically propelled cars on the surface, subway and elevated lines, would be justified in supposing that they had been in use a century.

The increase in trolley lines has meant a corresponding increase in power houses and a corresponding increase in engineers. The same rate of increase, if not greater, is shown in the electric lighting industry. Last year there were nearly 25,000 persons employed in the large power plants of this country, not to mention those that worked in the 50,000 or more isolated plants that furnish light in spots throughout the land.

This growth in numbers has also meant growth in intelligence and growth in responsibility, usually with corresponding increase in salary. A recent appointment of a chief engineer in one of the large power houses in the East carried with it what fifteen years ago would have seemed like a princely salary. Besides the pay that goes with it, the position of engineer means far more than that of an average workman, and the employer is the first one to recognize it, for to throttle the engineer would mean a lower working pressure of the wheels of industry.

Since the importance of the engineer is undeniable, it should be the aim and duty of all of us to put into the work the intelligence which the importance of the position demands.

An interesting and novel detail in connection with railway engineering in Japan is their method of dealing with the smoke and steam nuisance in tunnels. The entrance to most of the tunnels is covered with a closely woven curtain, which can be raised or lowered at will. A man is stationed at each end of the tunnel for the purpose of lowering the curtain immediately after the train has passed in. The result is that the vapor and smoke follow the train and emerge behind it, leaving a clear atmosphere in the tunnel for the next train.

THE SERVICE POWER PLANT AT THE ST. LOUIS EXPOSITION

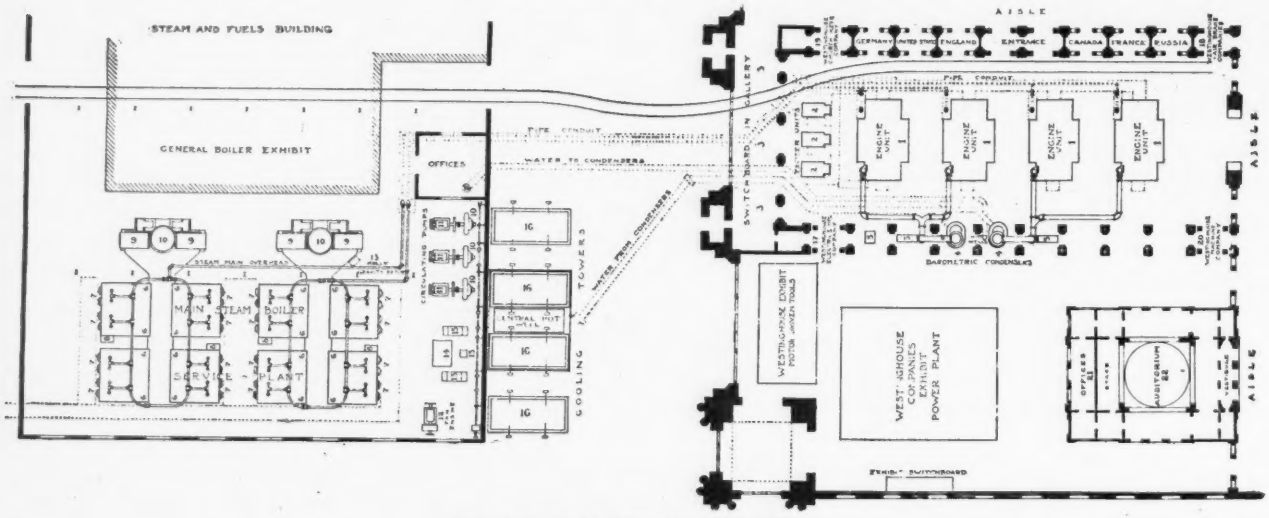
The casual visitor to the World's Fair at St. Louis will at once wonder, as he stands at some point of vantage and gazes over the 1240 acres of grounds and the countless buildings which are lighted with innumerable incandescent lights, where the power all comes from to illuminate this largest of expositions. Another visitor with still more curiosity will express surprise at the amount of energy necessary to run the hundreds of motors for operating the exhibits and concessions in various parts of the grounds, for pumping the water for the lagoons and basins, cascades and fountains and other applications. The visiting engineer is neither curious nor surprised to see this enormous manifestation of energy, as he is perfectly familiar with its transformation, and by wending his way to the Steam, Gas and Fuel Building and to the Machinery Building, the origin of the power which pushes its way through the arteries and veins of the exposition is found.

In the Steam, Gas and Fuel Building are located boilers of horizontal and vertical type, boiler feed pumps, mechanical draft apparatus and a coal storage and conveying system. The types of boilers shown there are the Babcock and Wilcox, Cahill, Heine and Climax, representing this country, and four foreign designs represent the best practice of Europe. The feed pumps shown include one Cameron horizontal, one horizontal Hooker, one Gould triplex vertical motor driven, one horizontal National, one Smith-Vaile horizontal duplex, and two vertical Warren pumps.

In the Machinery Building are located the reciprocating engines of this country and Europe, three steam turbines and a number of gas engines. The steam engines range in power from 5000 horse power to 200, there being about 20 units in all. The turbine units include one 2000 kilowatt Curtis, a 1000 kilowatt turbine of the Rateau type and a 400 kilowatt Parson type.

It being impossible to describe this entire plant in one short article, it will be the object of this paper to discuss the power plant which was built under contract by the firm of Westinghouse, Church, Kerr & Co. It consists of a plant of 12,000 horse power capacity, including engines, generators, exciters, switchboard, condensers, air pumps, boilers, mechanical stokers, mechanical draft plant, circulating and feed pumps, cooling towers, feed water heaters and piping. Comparing it with the service plant at the Chicago Fair, eleven years ago, it is not any larger in output, although the size of the units has increased. Where in Chicago 12-750 kilowatt units were used for this purpose, in St. Louis 4-3000 horse power units are employed, and while in Chicago, the 750 kilowatt units represented the largest polyphase alternating current machine ever constructed, to-day the 2000 kilowatt units are not the largest ever built, there being much larger engine units installed throughout the country.

The Exposition service plant, although it furnishes the main source of power and carries all the commercial operating and lighting load on the grounds as well as the Pike, and a large part of the decorative night illumination on the main buildings, is principally of interest to the engineer on account of its completeness.



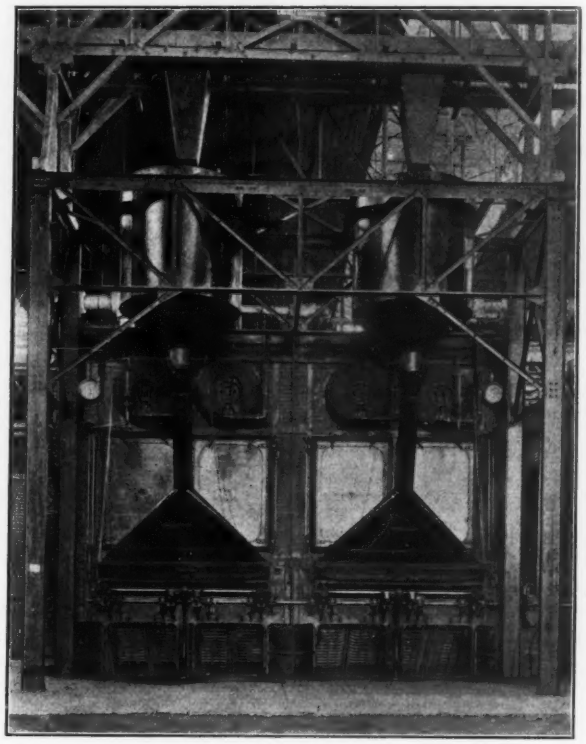
Floor Plan of the Exposition Power Plant.

Steam is furnished to the power plant by sixteen 400 horse power Babcock and Wilcox water tube boilers, located in Steam, Gas and Fuel Building. They belong to the forged header type and are set two boilers in a battery. The tubes and drums of these boilers are carried by steel frames independently of the brick setting. Two 10-inch loop steam mains, each connecting four batteries of boilers, deliver steam to the two 12-inch mains which carry the steam to the main units in Machinery Hall.

Each group of four batteries is provided with an independent induced mechanical draft equipment. Each equipment is provided with two fans, each capable of operating the boilers at their full capacity. The fans are three-quarter housed of the overhung type and operate on the inductive principle. They

are driven by Chandler and Taylor engines, the fan wheel being mounted on the engine shaft. The mechanical draft system is regulated by a valve which varies the speed of the fan to meet the fluctuations in pressure. A damper is so arranged that, if desired, both fans may be run simultaneously.

The firing of the boiler plant is done by means of Roney mechanical stokers, each group of four stokers in line being



Two of the 16-400 H. P. Babcock and Wilcox Boilers showing Mechanical Stokers.

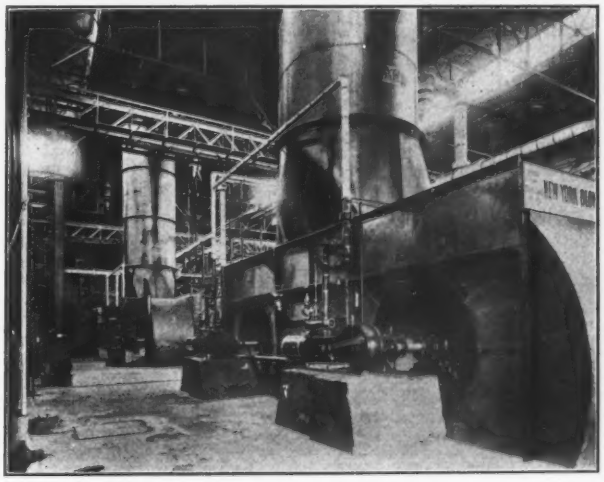
driven by a small Westinghouse engine, through suitable gearing. The stoker embodies the principle of the narrow rocking grate, stepped at such an angle as to facilitate a uniform descent of fuel from the coking arch at the top, to the dumping gate at the bottom, the coking arch, which embodies the principle of the reverberatory furnace, being instrumental in securing perfect combustion of gases contained in bituminous coal. The stokers receive coal from overhead hoppers supplied by the general conveying system, the ashes being removed through the basement.

Two complete systems of steam mains, 12 inches in diameter, convey steam to the main engines. The mains are carried beneath the floor in pipe galleries, anchored firmly to prevent creeping, and supported upon rollers to accommodate expansion and contraction. Entrained water collecting in the boiler room piping is drained out and automatically returned to the boilers by a Steam Loop and Holly Gravity Return, which is located in the boiler room. A similar system of piping for the boiler room and pumping auxiliaries is connected to the boilers between the drums and main valves, so that steam is always available at the boiler house auxiliaries. These operate non-condensing, exhausting into two Cochrane open feed water heaters, which reclaim a large amount of heat from the exhaust. In the engine room all auxiliaries operate condensing upon the main condensing system.

The four main units are alike in capacity and general design. The engines are of the vertical "cross-compound" Westinghouse type, of 3000 horse power capacity, built vertically to economize floor space, and compound in order to secure greater economy of steam, and operate at a speed of 85 revolutions a minute. As the generator and flywheel are mounted between cylinders, a connecting "receiver" is necessary, which is built of riveted boiler steel plate and conducts the exhaust steam from the high pressure cylinder to the inlet of the low pressure cylinder. Bed plates, one on each side, support the journals, engine frames, crosshead guides, and cylinders. The shaft, which is nearly three feet in diameter at the centre, is forged hollow from open hearth steel, fluid compressed to insure perfect homogeneity of metal. On account of the long span, the bearings are self-aligning, having spherical instead of cylindrical seats, resembling the ball and socket arrangement, thus permitting slight flexure of the shaft, due to the load concentrated at the centre. Both the bearing shells and the crosshead guides are arranged for water cooling.

Rocking valves of the Corliss type are located directly in the cylinder heads, which connect with "side pipes" paralleling the cylinder walls, a trip release gear on the inlet and a toggle motion on the exhaust controlling these valves. The gear permits a maximum cut-off of three-quarter stroke, enabling each engine to sustain for short periods a load of 5000 horse power. The speed of the unit is controlled by an enclosed type self-oiling centrifugal governor, adjustable while running for spring tension and sensitiveness.

In order to operate the generators in multiple, a small motor is provided at the engine, which moves an adjustable weight on the governor mechanism. This motor is controlled from the switchboard, so that the engine speed may be adjusted until the incoming generator has been synchronized and connected to the system. An automatic speed limit is provided on the



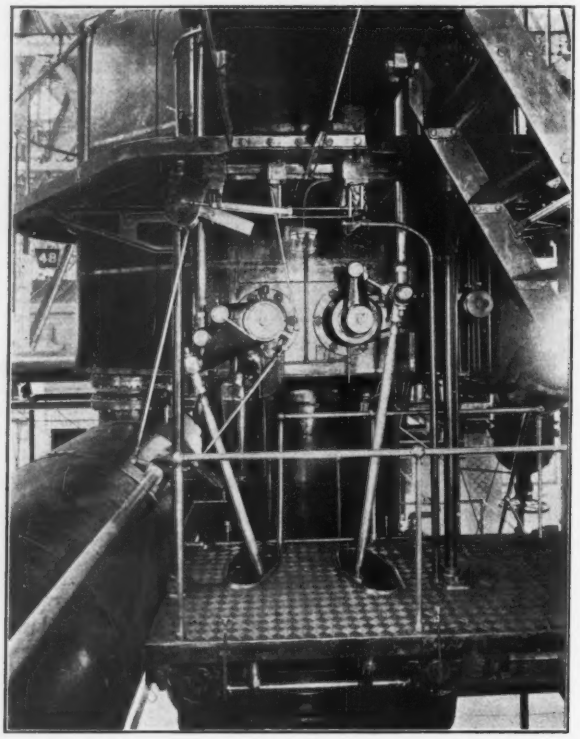
Induced Mechanical Draft Equipment.

engines, which instantly closes the throttle should the safe speed be exceeded through breakage of the governor mechanism. This mechanism may be operated also by the engineer from the main floor, by means of an electric switch.

The diameters of the high pressure cylinders of these engines are 38 inches and the diameters of the low 76 inches, with a stroke of 54 inches. The flywheels which weigh 170,000

pounds are 23 feet in diameter. The initial pressure on the high is 150 pounds and the vacuum on the low is 26 inches. The cranks are counterbalanced as they run at an angle of 90 degrees with each other.

The generators, which are rated at 2000 kilowatts at the usual temperature rise, are of the engine type, revolving field construction, with laminated armatures and fields, the armatures strap wound in partially closed slots, and the fields



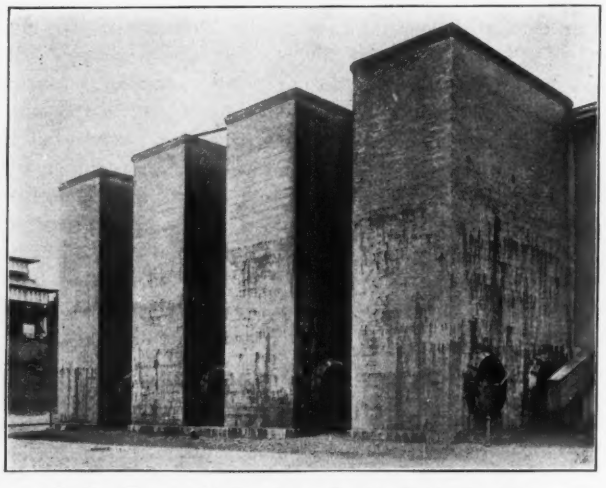
Corliss Type Valve Gears on the 3000 H. P. Engines.

wound with copper straps on edge. In order to obtain access to the winding, the entire generator frame may be moved out of position parallel to the shaft. Three 80 kilowatt, 125 volt Westinghouse engine type units furnish exciting current for the generator fields. The generators operate at a voltage of 6600, with a frequency of 25 cycles per second. The current generated is sent underground to substations in the various buildings and is used for the arc and incandescent lighting of the ground and buildings, the principal heavy individual load being the three 2000 horse power induction motors which operate the Cascade pumps. These pumps have an estimated capacity of 90,000 gallons a minute and are started and stopped at regular times during the day and night.

All main and exciter engines, as well as auxiliaries in Machinery Hall, operate condensing, two complete central condensing equipments being installed, each of 7000 horse power capacity and serving one-half of the plant. They are of the 40-inch Worthington elevated jet or "barometric" type, provided with entrainers and rotative "dry air" pumps for removing air from the condenser cones. Both horizontal and vertical types of pumps are in operation, one of the three being held in reserve. In case of loss of vacuum, an automatic relief valve allows the exhaust steam from the engine to escape through the roof. A motor driven valve operated from the floor below by a switch controls the steam inlet to each condenser. Circulating water is supplied to the condensers through a 30-inch main by a centrifugal pump of the Worthington turbine pattern, direct driven by a Westinghouse compound engine. The hot water discharged into the condenser hot wells is not thrown away, but is cooled for further use in four specially designed cooling towers adjacent to the boiler room. A second turbine circulating pump elevates the hot water into the towers and, in falling, the temperature is reduced by evaporation, which process is further aided by forced draft from the fans located at the base of each tower and driven from the boiler room by a Westinghouse compound engine. A third turbine pump unit is held in reserve and may be employed on either condensers or cooling towers. Motor driven valves operated by a switch from the floor control the outlet of each pump.

There are four cooling towers each consisting of a rectangular brick stack 52 feet in height. The interior contains 10 rows of gratings occupying about 20 feet of the height, a space of 12 feet below the gratings being taken up by the fans and a space of 20 feet above the gratings being used to convey the vapor above the top of the surrounding buildings. The effective area of each tower is 460 square feet, each equipped with four 120-inch Seymour disc fans, arranged in two pairs, each driven by a single shaft. All the sixteen fans are belted to a countershaft which is attached to the building wall, an 18 and 30 x 16 compound engine being used for power. All water that is lost by evaporation in the cooling towers is "made up" from the city mains.

The water for the cooling tower and condensers is pumped by three Worthington direct driven centrifugal pumps of the turbine type. The capacity of each pump is 17,000 gallons per minute with a 24-inch discharge under a total head of 50 feet. One of these pumps is used for the condensers, the second for the cooling towers and the third is held in reserve. They are each driven by a Westinghouse 18 and 30 x 16 compound



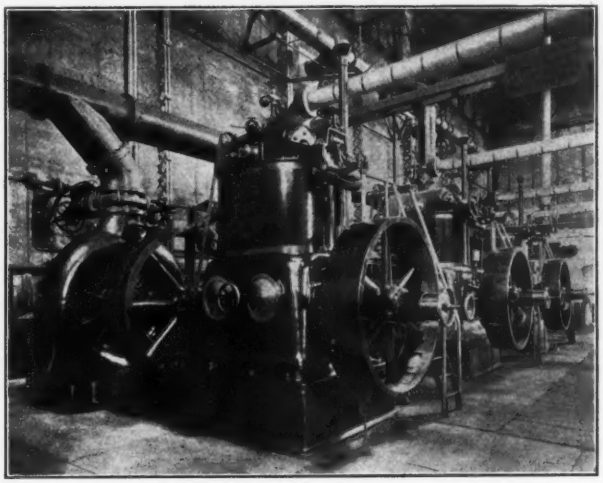
Cooling Towers with Fans for cooling the Condensing Water.

engine. The governors on these engines are adjustable and the speed can be varied, so that the pump output will be proportioned to the load.

The air or vacuum pumps consist of one vertical single-stage pump with the steam cylinder 8 inches by 12 inches and the air cylinder 16 inches by 12 inches and two horizontal

single-stage pumps with steam cylinder 10 inches in diameter and 18 inches stroke, the air cylinder 22 inches in diameter, 18 inches stroke. These pumps operate condensing.

The condenser is elevated about 30 feet above the hot well, and the water descends by gravity against the atmospheric pressure. The vacuum pumps are used to exhaust the air



Centrifugal Pumps directly connected to Westinghouse Compound Engines.

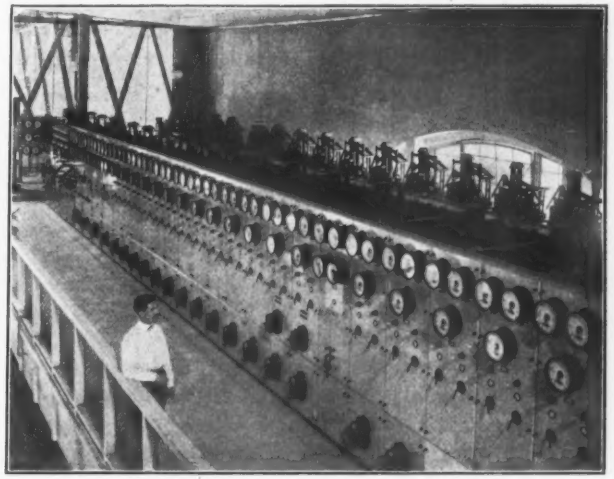
from the condenser and the steam pipe system. Before the air passes to this pump, however, it is cooled by an air cooler in the injection pipe, which decreases its volume and practically frees it from water. The dry vacuum pumps differ from other vacuum pumps in that, as the name indicates, no water is used in the air cylinders, the pistons being lubricated by oil the same as the steam cylinders and the clearance spaces being reduced to a minimum, as in air compressors. To still further increase the efficiency of this apparatus a small auxiliary valve is used, which after the exhaust valves have closed, opens a passage from one to the other side of the piston and permits the gases in the clearance space to expand into the suction side of the cylinder. Before the piston starts on the return stroke this valve closes and, there being no gas or air under pressure in the cylinder or ports, it draws at once from the condenser. This method greatly increases both the capacity and efficiency of the pump. The absence of water and the positive control of the suction valve permit a high rotative speed.

The positive inlet and discharge valves of the horizontal vacuum pumps are adjustable by a hand wheel, while the steam is controlled by a slide valve with an adjustable eccentric to vary the point of cut-off according to the steam pressure. The suction air valve is positively driven by an eccentric on the shaft, which is so set as to open the ports fully at the proper time, leaving an unobstructed passage for the attenuated air and vapor to enter the cylinder. The steam and air pistons are on a common piston rod. In addition to the horizontal vacuum pumps there is one vertical pump, with an enclosed crank case, the air and steam pistons being on independent rods. The other features of the vertical machine, however, do not differ materially from the horizontal machine just described. All three pumps draw from a common vacuum header, which in turn is connected to the cones of the two condensers. The vacuum pumps are supplied with steam from the engine auxiliary piping system, and the exhaust is turned into the main condensing system. The air discharge is led through spiral piping to the roof.

The three boiler feed pumps are of the Worthington type, one being vertical and two being horizontal. The vertical pump belongs to the duplex type with dimensions 14" x 10" x 18". The two horizontal pumps are compound duplex outside packed plunger type, steam cylinders 9 and 16 inches by 15 inches stroke, the water plungers being 7½ inches diameter and 15 inches stroke.

Electric current from the Exposition service plant and from exhibit power plants in Machinery Hall is transmitted over the network of underground cables at a potential of 6,600 volts, transformers being used only at distributing points. All Exposition power is controlled from the twenty-nine panel marble switchboard on the upper gallery over the west end of the main aisle. The electrically operated oil switches are behind the operating panels, the busses and instruments on the lower gallery, busses being in duplicate and housed in a structure of masonry with intermediate barriers. All main generator and feeder switches are installed in independent fire proof vaults, and are electrically operated from the main panel, indicators showing whether a switch is open or closed. Remote control of high tension current is exclusively employed, the switchboard being supplied with Westinghouse high tension, oil immersed, automatic circuit breakers, and with ammeters and voltmeters for each space.

In the design of the service plant, no important feature of a modern central station was omitted. The Niles electric traveling crane over the main engine units in Machinery Hall is of 40-tons carrying capacity and bridges a span of 80 feet. It is equipped with three Westinghouse motors—one, of 20 horse



Exposition Service Switchboard which controls the entire current for Exposition Service.

power capacity, to drive the bridge, being located at about the centre of the girder, and two, one of 20 horse power capacity for hoisting and one of 5 horse power for moving the trolley, being secured to the trolley itself. The motors are controlled from the crane cab, and current at 110 volts is supplied from the exciters for the main engine units.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

More About Opening and Closing Valves.

EDITOR THE PRACTICAL ENGINEER:

As there seems to be a considerable interest shown in this subject, a few more lines in relation to it may be acceptable, but first I wish to say to those who have expressed favorable opinions of my articles in the mechanical papers, that their kindly expressions are appreciated and they are hereby thanked sincerely for the same.

Gentlemen, every article of mine that you have read, expresses my belief and ideas on that particular subject, and although I prize your good opinion very highly, you cannot expect me to write in favor of a plan that I know is wrong, nor allow condemnation without qualification of a plan that is not wholly bad. Under these conditions do not again express the idea that I do not mean what I say, as I do mean every word of it, and know that the ideas expressed are right. If you have failed to read my statements with the care they deserve, or choose to charge me with being offended because I defend ideas that I know are right, your course in the matter is regretted, but it is not within my province to prevent it. I sincerely hope that sooner or later the time will come when an engineer can advocate with spirit what he knows to be right without being charged with insincerity, or accused of improper resentment.

As illustrating the carelessness with which such letters are sometimes read, I refer to page 18 of "The Practical Engineer" for October, where the following appears: "I hardly think it fair for W. H. Wakeman to assume from his wide experience his judgment should be unquestioned, as put forth in his article." This writer seems to have entirely overlooked the fact that somebody else wrote the article that started this discussion, while I am questioning the advisability of failing to qualify the statements made in said article. Another point which he has evidently overlooked is that I am not asking anybody to accept my judgment in the matter, but am simply presenting the results of every day practice, which prove that I am right in saying that the use of a wrench on a valve does not always ruin said valve.

In the next paragraph this writer says: "On the other hand, by waiting until the disc is hot, which generally makes it soft at first," etc. Such a statement can only apply to a valve fitted with a hard rubber disc, showing that the author of it is working on a narrow gauge plan, for he only considers one kind of a valve, when my statements apply to all valves. It makes quite a difference whether you have a globe valve (which is practically a balanced valve) working almost without friction, or a gate valve with a heavy brass disc that is nearly as hard when hot as when cold. Such a valve is frequently located so that its stem is horizontal, therefore the gate is not suspended, but must be forced over a comparatively rough surface, and when nearly closed it is far from balanced, which greatly increases the friction.

In the fifth paragraph of my letter in the July issue, I referred to some valves that were put into service ten years ago, then asked some questions which have not been answered. Until replies are made to them, my opponents are evading the real question at issue. I have looked up the matter still further and find that some of the discs used in those valves are still in my possession. One of them is marked "6 years," which means that it was used for six years. It is still nearly perfect, but shows a little wear on one side. It could be reversed and used for a long time. This is one of the valves on which a wrench has always been used, and will be whenever needed. After reading this statement, will these writers still claim that the use of a wrench always ruins a valve? If so, then what is the use of presenting evidence on the subject?

During the six years that this disc was in use, I was obliged to renew the disc several times in another valve that is practically on the same line of pipe, although a wrench has never been used on this valve. In view of these facts it seems to me as if some of the writers on this subject had better get out of deeply worn ruts, and wake up to the fact that others who do not agree with them, mean what they say, and are still doing careful and successful work. Now, if the results in the above-mentioned cases were reversed, it would have been evidence in favor of my opponents, but as the valve on which a wrench was used lasted longer than the other, it is quite possible that they will ignore it, although this is not an isolated case.

I notice that one correspondent claims that my way of doing business encourages shiftless natures. If necessary, I can produce evidence to prove that in the city where I have had charge of various plants for twenty-six years, my reputation does not warrant the statement he makes. An engineer's home reputation is a correct indication of his character, as a general rule. It is not possible for a shiftless engineer to give satisfaction in the position I have held for more than ten years, and am still holding.

New Haven, Conn. W. H. WAKEMAN.

Opening and Closing Valves. Remedy for Leaking Valves.

EDITOR THE PRACTICAL ENGINEER:

I have been an interested reader of the argument between Mr. Wakeman and A. T. for some time on the handling of valves and I must say I will have to take sides with A. T. I don't think any engineer that thoroughly understands the construction of a valve would advise any one to use a wrench or any other form of leverage to close a valve that is leaking, without expecting to damage the construction of the valve. Especially is this so with the taper disc valve which, when under additional leverage, becomes a wedge and forces the seat apart, thereby straining it beyond future usefulness or repair.

My plan is to close the valve with the wheel and if the valve still leaks, repair it, for there is undoubtedly something wrong. The plant where I am working uses asbestos disc valves and

were I to follow the advice of Mr. Wakeman, I would have nothing but leaky valves. We have a valve reseating machine which I consider one of the most necessary articles around the steam plant. It is worth its weight in gold and were more of them in use, there would be less leaking valves.

Salem, Oregon. J. T. W.

Would Use a Wrench for Closing Valves.

EDITOR THE PRACTICAL ENGINEER:

If the incident is not closed, I would like to butt in on the controversy between Mr. Wakeman and A. T. I think that any engineer, who has never had occasion to use a wrench to make a valve close tight, must have had his experience limited to the care of a vacuum heating system where, if a valve got to leaking, he could take the bonnet off at any time and close the opening with a soft piece of belting and repair the valve at his leisure. Let us see how A. T.'s beautiful theories would work in practice.

In the plant that the writer has had charge of for a number of years, there are 4 72-inch return tubular boilers. They are all piped to a 10-inch main with a 6-inch Jenkins' angle valve for a stop valve. The boilers are run six days each week. The Insurance Co. object to the steam being turned off the 10-inch main on account of the fire pumps, unless extra watchmen are put on to watch the factory. We wash one boiler every Sunday, each in its turn. We let the fire go out at 5 P. M. on Saturday and blow off the next morning. Sometimes the stop valve will not close tight and the steam leaks back from the other boilers.

Now, what am I going to do, blow off under pressure or let the boiler go without washing until I can get a chance to see what the trouble is, or, use a wrench to get a little extra leverage? These valves have been in use for twelve years and it is only once in a great while that we have any trouble with them not shutting tight, and if there is any trouble, we use a wrench.

Wallingford, Conn. D. S.

Stationary versus Steamboat Firemen.

EDITOR THE PRACTICAL ENGINEER:

The other day, while visiting a sub-editor on a mechanical paper in New York, he handed me a copy of "The Practical Engineer" with the remark: "There's some good matter in there—take it with you." It was the first time the paper had come under my notice and as I perused its pages, I was surprised at the value given for the money. The article by J. G. S. particularly drew my attention. As a marine engineer, I must say that our friend's ideas of a marine fireman are, to say the least, crude. He writes: "The marine fireman is supposed to know nothing but shovel coal and boast over it. This is about all he is capable of doing." Now, as an engineer on one of our largest and fastest ships, I feel I must take up the cause of the average marine fireman, for, of course, there are black sheep in every flock.

We leave port each voyage with a fireroom crew of about one hundred and forty. We always find that a percentage of the firemen lack the necessary qualities for their place at the furnaces, and reducing them, promote our best coal-passers in their places. Now, if they have only to "shovel coal," how do we weed them out? Any otherwise useless clod can shovel. A good fireman knows exactly when to use his shovel, hoe, or slice bar; what thickness of fire to carry to get the best results from different kinds of coal, and last, but not least, how to clean a fire quickly and thoroughly. This in an atmosphere averaging 110° Fahr.

Again, J. G. S. says: "I have found the steamboat fireman in hard jobs would last only from one to four hours." I don't suppose our friend was ever out at sea in a disabled ship, tinkering up her engines, or patching a boiler against time, with the ship rolling her decks under. That is when to make the endurance tests, and I have always found the fireman a great help and a good sticker. We usually find the stationary fireman a failure at sea and he always has some excuse—either the heat, or the style of firing. As we know little about new men beyond their official "number," it is only *after* we have disrated them and they protest, we find out about their shore experience. Finally, let me point out that the marine fireman has to assist the engineers in overhauling the machinery in port, can make knots, splice ropes, and rig as good as the average deck hand; mix paint and numerous other little jobs which go to make him truly "the handy man."

New York. X. Y. Z.

EDITOR THE PRACTICAL ENGINEER:

I have seen J. G. S.'s letter in the September number of "The Practical Engineer" but I surmise that the heading should have been "Engineers, instead of Firemen." So far as an argument on firemen goes, he certainly has had some experience in steamboat firing and has never made a success for the reason that he was put in that position by the captain or owner of the boat, and as things were not run according to his idea, he says "steamboat firemen should not be condemned but should receive some sympathy because their associations are not advantageous for the gaining of knowledge," but "when they procure a job on shore where they come into contact with practical and theoretical mechanics, not until then should they be disqualified if they fail to take advantage of their experience at sea."

For my part, I think Mr. J. G. S. could tell more about how that fireman got his 50 horse power license than any one else. He must have run a hot water heating system before he got his license, and as one may see, he had a very good chance to see how much coal a fireman could shovel and how long he would last at it.

Now to begin with, Mr. J. G. S. would have fared better had he gone to the engineer of that boat and had him "ship him up." It is a law that the captain can place any one in the pilot house to learn the business, but there is no law that says the engineer must teach or give any information of any kind. Then he speaks of the fireman "on shore"; how he runs with drip cocks open as well as different valves. I will tell Mr. J. G. S. here that a steamboat fireman is the most particular person on the boat about even a small syphon valve being open and blowing through. I have watched them and they will walk the length of the boat to shut one off.

Now, their endurance is no more than any other men but, just like a trade, standing or firing in front of six or eight boilers will enable them to become used to it and, of course, stand more of this great heat. Stationary firing in nearly all cases is regular, while steamboat firing is not. Sometimes the engineer has to full stroke the engines to make the boat steer

at a swift point in the river, or to run slow at a shoal place, or make a landing, so that in my opinion, I cannot see where there is any comparison between stationary and steamboat firemen.

St. Louis, Mo. S. J. H.

The Engineers We've Had.

No. 6.—Lament of the Old-time Engineer.

Yes, my time is gettin' shorter, and I soon will have to go
Back to the fire-hole, to roast and fry.
And my poor old weary bones, I know, can't stand the pressure now,
They used to stand when I fired as a boy.
I can see my finish comin', as a first-class engineer,
I did not think 'twould come so awful fast;
And I always thought book-larnin' was no use to me at all,
But knowledge triumphed over me at last.

Their new-found plans and fixin's for to make the engine talk,
I always looked upon as many tricks,
But their fancy indycators, and their planny meters, too,
Have left me in my old age, in a fix.
I never dreamt a school kid ever lived could take my job,
Or tell me, what I worked my life to know,
But at last I'm up agin it, and it does seem mighty hard
That his knowledge has won, and I must go.

Take my advice, you fellers, that are starting in the game
Of making someone's wheels of commerce hum,
If you don't want to study, or to keep up with the times
You'll pretty soon like me, be on the bum.
I wish that I had sense enough to see things as they are,
And throw my old-time prejudice aside,
But now, when 'tis too late, I know that I'm behind the times,
And in the fire-hole now, I must abide.

So now, good-bye, old engine, I have done the best I could,
No more your knocks and grunts shall reach my ears;
For I see the school kid comin' with his indycator cards,
His magazines and books and fixin'-gears.
To-morrow he'll be callin' you a thief, and an old liar,
And that you're not a workin' right at all,
Well, I hope that my sad fate may prove a warnin' unto some,
Before, like me, they're driven to the wall.

Detroit, Mich. J. J. H.

Public Opinion as to Boiler Explosions.

Editor the Practical Engineer:

I suppose when the readers see the heading of this article they may be tempted to turn over to the next page for something else to read that has not been in print so much and when they can find nothing else to interest them, in all probability they will give it their attention. But nevertheless, I have never seen anything in print yet in the papers treating on steam engineering but that there was something of benefit to many. All writers have their way of expressing themselves, and in the different ways it is done, we learn something we did not realize before, or perhaps a majority of us do. What prompts the writer to take up this subject in this: A fellow workman in the factory in which I am employed at the present time, made the statement that all boiler explosions are caused by incompetent and careless engineers. This is a wrong impression for anyone to have. While it is often the case, the whole cause of boiler explosions does not wholly lie in the fault of the engineer in charge.

While all persons who are placed in charge of steam boilers and engines are not always engineers by any means, the public must take some of the blame for allowing persons who absolutely know nothing about the nature of steam to have charge of it in any way.

The writer feels it his duty to defend his brother engineers on this one point, for it is wrong to allow anyone to have this impression. If the people who are expressing themselves in this way would only take the trouble to look into the matter or post themselves a little on the subject, they would see differently.

Ignorance and neglect I will admit have caused considerable explosions, but it is not wholly the fault of the attendant. The manufacturer of the boilers must come in and bear part of this burden and he comes in for quite a share of it; also the owner of the plant, who is too anxious to reduce expenses and will let a good, competent engineer go to whom he pays $3.00 per day and will hire a man, who has no knowledge of steam, for $1.75 per day, and take his chances. I have heard manufacturers say that anyone who can shovel coal and keep steam up is as good as any engineer and this kind of man is allowed to run or have charge until something lets go.

Some of the worst explosions that we have had have been due to the single and double riveted lap joint boilers, and I hope the day is not far distant when the law all over this great country will make it a criminal offence to manufacture a single or double riveted or in fact any lap joint boiler, and will allow nothing but the double welt butt joint for all longitudinal joints of cylindrical boilers.

Boilers that explode from having a heavy coating of scale bagged or burn sheets, and from corrosion or from overpressure due to overloading of the safety valves, etc., are the fault of the engineer or the person in charge, for he should know better or else leave this profession to those who do.

Defective design and poor workmanship are due to the manufacturer. The engineers often make a mistake in taking for granted that in all single riveted boilers the riveted joint is 56 per cent. the strength of the plate and that all double riveted joints are 70 per cent. of strength of solid plate. The efficiency of all single and double riveted lap joints is not 56 and 70 per cent. of the strength of the plate by any means. All manufacturers do not pitch the rivets the same. Some stretch them out a little, while others crowd them too much; in both cases, if the size of the rivet is not right, it weakens the riveted section and reduces the efficiency.

Sometimes short jobs have been discovered. The manufacturer supposed that he had a boiler with a double riveted lap joint boiler and that the longitudinal joint had the efficiency of 70 per cent. the strength of the solid plate. But the inspector discovered that there had been a short job on this boiler after it had been in operation for over a year and had been worked up to the pressure at which it had been designed for. It was a wonder this boiler did not explode. I would like to know who would have been to blame had this boiler exploded?

The riveted section of this boiler was not as strong as a well

designed single riveted boiler, and the owner of this boiler had contracted in good faith for a well designed double riveted lap joint boiler with the efficiency of 70 per cent. Had this boiler exploded, the poor engineer would have had to shoulder the blame beyond a doubt, so far as the general public was concerned, as they would not understand the meaning of a short job and would take it for granted that the engineer was short of water in the boiler.

Abington, Mass. A. T.

Rodney's Troubles.
Or Do We Need a License Law in Michigan?
(Thirteenth Letter.)

Mi editur deer sur i hev got intu a lot ov trubble agin. i hev bin kleenin thu fluse ov thu biler fur thu last 10 yeers with a skraper evri time i wud run mi injine. well thu uther day thu skraper giv out and henry told me tu go tu thu villidge and git a pattent flu bloer. well i bot the hull biznus and brot it hoam and henry sed hed help me tu put it on thu biler, so when thu biler wuz kold we luked around fur a plais tu hitsh the nu riggin on tu. thur iz a pipe leedin out frum the top ov thu dume, i think that iz whut henry kalls it and this pipe gose ovur tu thu wattur glas biznus. wel we tuk out a irun plug frum thu pipe and put a short peese of pipe with threds on both ends ov it intu whear i tuk out the plug. i skrewd thu valv whut kum with thu bloer on tu thu short pipe and then i kud shut it of enny time i wantid tu. henry sed lets get steem on yure biler and see how the bloer works, i thot it kind o' funny ef the durned thing wuddent wurk without no steem, az thu skraper kud be uzed a gud deel bettur when thu biler wuz kold. u ot tu heer henry laf at me when i ast him about it and he sed don't u no u kan't uze a flu bloer with out steem preshur or air preshur. so this iz 1 uv thu kwestuns i want tu ask u. i no whare i kan git thu steem preshur frum but whare can i git the air preshur frum? i wunt ask henry enny thin more fur he most allus lafs at me.

while we wus putten thu pipes tu gether the cheef injinear frum the villidge power hous wuz waken bi and he got tu tokken about the injine and 1 thing or anuthur and mr editur he wanted tu no if i wuz going to wash out thu toobs with that arengment. i told him i gesd i wuz fur it wuz a nu idee and if it kleend em i didunt kare if it washd em ur how it dun it. thu power hous man went away with a grin and a snikker. now what wuz the mattur with him? mebby he thinks he nos it awl but he'ul find thet thur iz a fu besides him whut kin run a steem injine. du u no mr editur i nevur likd thet feller sense thu time he wuddent giv me a job in thu villidge power hous. well mebby he wont allus be thare and mi time will kum fur a chans then. i lost 1 ov the wates frum whut henry kalls the guvernur and i wish u wud tel me whare i kin git a nu 1, and plees tel me whut kind ov paint u usd on ure thrasher biler when u wus a travulen injinear, u must hev usd a gud menny kinds ov paint fur u sed u hev run mecheens awl ovur the kuntry

plees ansur rite away fur ime in a hurrey tu heer frum u and oblige

rodney gumkirk
kare mi dad orkners korners
munrow kounty
meshigan.

Expansion of Water. Answer to A. B. C.

EDITOR THE PRACTICAL ENGINEER:

In the August issue of "The Practical Engineer," Mr. A. B. C., of New Bedford, Mass., wants to know how much pressure there will be in a heater coil that is entirely filled with water at a temperature of 60 degrees after which both ends are closed tight and then the temperature raised to 212 degrees.

Assuming that there was no mechanical pressure put upon the water it is a simple problem. Before the water boils there can be no increase of pressure except from expansion of the water by heat, but this pressure is overcome by the expansion of the pipe from the same source. Now water boils at a temperature of 212 degrees in an open vessel, but with the vessel closed it will not boil at 212 degrees, hence there is no steam generated and we have but a pressure of 14.7 pounds, or one atmosphere, until we raise the temperature to 300 degrees Fahrenheit.

Coatesville, Pa. W. H. S.

A Bad Case.

EDITOR THE PRACTICAL ENGINEER:

As a travelling man visiting engineers, the thought occurred to me to give you one or two of the many experiences I have had, which may be of value to some running engineer.

In a small town in the West, I was calling at all the plants, in the course of which I came across a place the condition of which indicated gross neglect on the part of the employer and the extreme carelessness of the engineer.

The plant was in the cellar, the only means of ingress and egress being a rickety pair of stairs on the outside of the building, to a dirt floor on which the boiler, 35 horse power, and engine, 20 horse power, had been placed, with a very meagre foundation.

The first thing I noticed was the absence of a water glass, two try-cocks serving this purpose. Neither was there a steam gauge. Naturally, my eye turned to the safety valve, and, behold me, the weight was on the extreme end with an additional weight to keep it down.

I accordingly asked the engineer—a *man* about 20 years old, how he got along without a steam gauge. His answer was, "I am used to it." His very extraordinary answer as to how often he tried the safety valve was: "Whenever I think of it." When I asked him who figured out the safety valve before setting it, his brilliant answer was: "I guessed it."

Now, the question is, who should be held accountable for any damage that might happen; the employer or the engineer? The employer certainly, for he knew that there was no water glass, no steam gauge, and he, of course, knew that the man in charge was not a competent person, else he would not take such a job, endangering his own life, as well as placing the lives of all the employees in danger.

It is a sorry fact that the condition as above noted is not uncommon; and it seems the smaller the plant, the more neglect; the larger the plant, the greater the care.

Instead of a limited license law, permitting a man to run a plant over a certain horse power, the law should read: "Any boiler carrying over 15 pounds pressure."

Brooklyn, N. Y. W. S. F.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

TO OUR READERS:

As we have been in receipt of a number of letters to which no names or addresses have been signed, the Editor wishes it distinctly understood that all communications must bear the names and addresses of the writers, or they will not receive any consideration. As you no doubt know, we do not wish the names for publication, unless the writer prefers it, but merely as a matter of good faith on the part of the writer. We have also received a number of questions without any names or addresses, and if the writers wish any replies, they will receive the answers by conforming to the above request.

EDITOR THE PRACTICAL ENGINEER:

Kindly inform me of a good receipt for making grease which can be used for elevators.

Providence, R. I. G. D.

A grease which is said to give good results for all kinds of machinery is made as follows:

Mix together at a boiling heat 1000 parts of petroleum, 88 parts of graphite, 3 parts of beeswax, 9 parts of tallow and 3 parts of caustic soda.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

I have read several articles on figuring the horse power of a boiler by evaporation, but do not understand it yet. Would you kindly publish a rule in your next issue? For example, what is the horse power of a boiler that is evaporating 2000 pounds of water per hour, steam pressure 120 pounds, feed water 204 degrees, or what is the horse power using the same amount of water if the steam pressure is 90 pounds and the feed water 180 degrees?

Denver, Col. E. F. S.

The calculations of a complete boiler test, including the finding of the horse power, were given in the September issue. Another method of calculation was given in the June issue. One of the best ways to think about the horse power of a boiler is to realize the number of pounds of water it is capable of evaporating in one hour. This is given by the well-known rating that one horse power is equivalent to the evaporation of 34½ pounds of water per horse power per hour from and at a temperature of 212 degrees Fahr., or 30 pounds of water per hour from a feed water temperature of 100 degrees into steam at 70 pounds gauge pressure. This evaporation in each case is the equivalent of the transfer of 33,305 heat units in one hour.

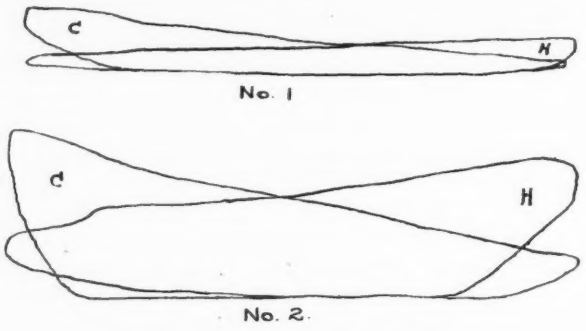
In the above example, steam at 120 pounds has a temperature of 350 degrees and its latent heat of evaporation is 866 heat units, so that the number of heat units given to each pound of water from a feed water temperature of 204 degrees is equal to $(350 - 204) + 866$, which gives 1012 heat units required per pound of steam. The horse power of the boiler can then be obtained by multiplying 1012 by 2000, the number of pounds of water evaporated per hour and the product divided by 33,305, the number of heat units in one horse power. This gives $(1012 \times 2000) \div 33{,}305 = 60.7$ horse power.

When the steam pressure is 90 pounds, the latent heat of the steam at that pressure is 880 heat units and the temperature is 331 degrees. As the feed water temperature in this case is 180, the horse power of the boiler is $(331 - 180 + 880) \times 2000 \div 33{,}305 = 61.9$ horse power.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

I enclose herewith a sample of two cards taken from a 16" x 24" slide valve engine. Card No. 1 was taken with no load and Card No. 2 was taken with full load. The engine has a single eccentric with a throttling governor.

When the night engineer came on, he claimed that he could not keep steam on the boiler, which is a 72" x 18' tubular boiler. Card No. 2 is the way he left the valve after setting. He said that he took the steam chest cover off and left the valve



Indicator Cards from Throttling Engine.

with a 3-16-inch lead on the head end and no lead on the crank end.

What I want to know is, is it possible to take Card No. 2 when the engine has got 3-16-inch lead on the head end and is blind on the crank end?

Woodville, Ohio. P. A.

Since the lead of an engine is the amount the steam port is open at the beginning of the stroke, it follows that the port must open before the crank reaches the dead point, if it has any lead. The effect upon the diagram is to give a rising compression line. Unfortunately it is always difficult to say when compression leaves off and when admission begins, and this is rendered still more difficult in this case on account of the steam being throttled. It appears from Card No. 2 that the crank end is better than the head end so far as steam distribution is concerned, and it is apparent that the head end has more lead than the crank end although it is hard to under-

stand why the initial pressure of the head end is so much lower than the crank end. There is no doubt something wrong with the setting of the valve as it seems that the port is not open wide enough on the head end to allow the full pressure of the steam chest to enter.

It is therefore impossible to say exactly whether it is possible to take Card No. 2 with a 3-16-inch lead on the head end and no lead on the crank end, but as the valve closes sooner on the head end, it is probable that it opens sooner, and therefore it has more lead than the crank end, but probably not as much difference as 3-16-inch. In general, it might be said that both cards are good ones and are very fair samples of cards taken from a slide valve throttling engine.—[Ed.]

EDITOR THE PRACTICAL ENGINEER:

I have been a subscriber to your paper for about five months and I have gained a lot of information through the "Question and Answer" columns and I am looking for more. Will you please tell me through these columns the best way to fit and grind into a steam tight bearing, allowing for expansion, as double poppet steam and exhaust valves?

I have fitted a number of them and in so doing have followed out, as I thought, a natural rule, as follows: File the seat until the valve showed a general bearing and then grind them until they were perfect on both seats, removing shoulders until, when finished, they showed a perfectly smooth bevel with the bearing at the bottom the width of the seat. I have been told so many different ways by different engineers that I am at a loss to know which is proper and so I appeal to you to furnish me with the proper method of doing the work.

I would also like the opinion of any one who would care to give it through the columns of "The Practical Engineer."

Quincy, Mass. C. C. C.

The general opinion of engineers is that your method of grinding valves is correct, as a valve that is ground in cold will usually stay tight when hot, as the difference of expansion between the valve and seat will not be sufficient to cause any leak. We would, however, be pleased to hear from other engineers on the subject.—[Ed.]

What is the Trouble?

EDITOR THE PRACTICAL ENGINEER:

I have had a little experience which I wish to relate and I would like your readers to tell me the trouble.

In the plant where I am employed, there is a 12" x 14" throttling governor side crank engine belted to a saw arbor. It was running all right when suddenly it commenced to labor hard and when shut down, the united efforts of four men on the drive wheel was not sufficient to turn it off the centre. I looked it all over and found the bearings to be all right. The question is, what was the trouble?

Stockton, N. Y. H. J. I.

EDITOR THE PRACTICAL ENGINEER:

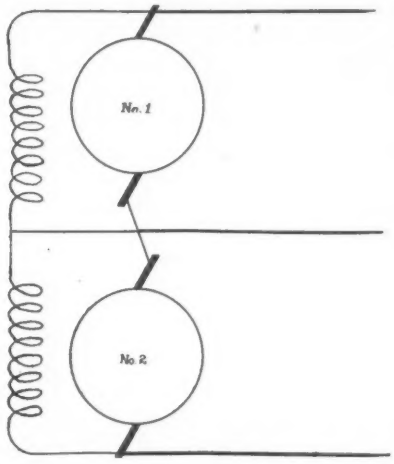
Kindly answer the following question through your valuable paper:

I have in my plant four direct current dynamos connected on the three-wire system. During a recent storm the mains got crossed so as to form a short circuit. Only machines No. 1 and No. 2 were running at the time. When the short circuit was removed, I found machine No. 1 reversed.

Why did machine No. 1 reverse and why did the reversal not show up until short circuit was removed?

Kaukauna, Wis. J. K.

It is probable that when the short circuit occurred on the line, the current flowed back on the mains of No. 1 machine,



Dynamos connected on Three Wire System.

thus reversing the direction of the current in the fields. The effect of that would be to change the magnetic fields so that when the machine was started, its polarity and hence the direction of the current in the armature would be reversed. This usually does not happen under ordinary circumstances as there is always a small residual magnetism left in the fields when the field current is turned off, which is available to help build up the field in a self-exciting machine. If this residual magnetism became reversed, due to some outside influence, then the machine would build up with its positive and negative brushes reversed. This is probably what happened to No. 1 machine.—[Ed.]

Keystone Grease as a Lubricant.

BY THOMAS O. ORGAN.

The cost of lubrication in a power plant or industrial establishment is a matter that often receives insufficient consideration. Such consideration as it does receive generally results in an effort to economize by purchasing lower priced oil. That this is false economy is well known to every engineer who has made a careful study of the science of lubrication. It amounts to a case of "saving at the spigot, while wasting at the bung," for low grade lubricants are dear at any price, as a given quantity of a high grade lubricant will go twice as far in most cases as twice the amount of low grade stuff, but if that were all, the subject would not be worth discussing.

The principal reason for avoiding low grade lubrication is its tendency to gum up quickly, and carbonize easily, leaving an undesirable residue which cuts away the journals and bearings rapidly, and adds greatly to the friction load.

This friction load is a feature which is not sufficiently considered. It is the "blind burden" of a power plant, the unseen

foe that is everlastingly bearing down and growing heavier as the plant deteriorates. It is ever present and always expensive; ever consuming, but never producing anything of value.

Nearly every engineer knows that his friction load is heavy; many can tell exactly what amount of power is consumed, but very few realize how much this waste could be reduced simply by the use of proper lubricants. There are numerous cases where it has been reduced from 25 to 50 per cent., and often more.

The plant I have charge of was considered in good condition when I came here, yet by simply going over my shafting, lining it up in places, and changing lubricants, I have decreased the friction load nearly one-half, saving about three hundred dollars a year on coal, and fully a hundred dollars a year in first cost of lubricants. My predecessor used a cheap grade of common, black machinery oil, for which I have substituted Keystone Grease. I find that this grease is not only a good lubricant, but that it is cheap, for a small quantity of it goes a long way. Another advantage of grease over oil is that it feeds only as needed, and provides an ever-constant reservoir of lubricant in case of sudden heating.

———o———

An Improved Pump Governor.

The accompanying illustration shows the latest development in the Steam Pump Governor line, which will readily be appreciated by engineers. That a Steam Pump Governor is a necessity no longer admits of any argument and the advantages of regulating the water pressure of the pump automatically are very numerous.

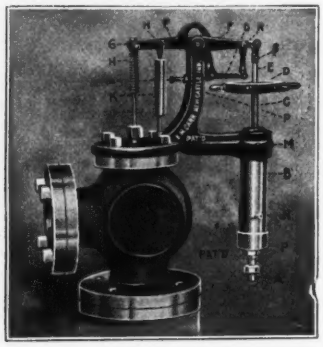
The Carr Pump Governor, manufactured by E. M. Carr, of New Castle, Ind., not only maintains a uniform water pressure on the mains, but also prevents the pump from racing in case a greater quantity of water should be consumed than the pump is capable of delivering, as in the case of burst water mains or hose.

The speed-controlling device is very simple and can be so set as to prevent the pump from racing, regardless of the drop in the water pressure. The lever F, F, is hinged at its centre but is held in a rigid position by spring K and the water pressure on the piston. This spring has sufficient strength to easily open the valve, and it also assists greatly to balance the water pressure on the piston. The lever becomes flexible only when a greater quantity of water is consumed than the pump is capable of delivering.

It will be seen that the end of the lever F, carrying the steam valve, extends beyond the centre support. At its lower end is pivoted the cam lever O. The cam lever is linked to piston end of lever at R, and through this link the cam receives its motion.

So long as the pump is operated under ordinary conditions, a constant water pressure will be maintained and the lever will remain rigid; but should the water pressure drop from any cause sufficient to cause the pump to increase its speed to the limit to which speed controller is set, the cam O will be brought to engage with fulcrum P and the lever F, F, will become flexible, which will prevent any farther lift of the steam valve. Should the pressure continue to fall, the cam will be brought farther around against the fulcrum, forcing the end of the lever carrying the cam outward, and the end carrying the valve downward, bringing the valve closer to seat, thus throttling the steam, and maintaining a safe speed of the pump regardless of the drop in water pressure. Should the increased consumption of water be stopped, the pump will continue at a uniform speed until the water pressure to which the governor is set is again reached; the cam will be disengaged from the fulcrum and the governor will operate as before.

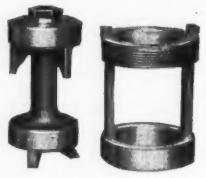
The regulating hand wheel D always remains cool and can be handled without injury to the hands. It can be placed in



Carr Steam Pump Governor.

any position desired, which is a good feature that should not be overlooked. All that is necessary to make the change is to simply remove the bolts in the valve cover and move the wheel to position desired. By this arrangement, the engineer can place the hand wheel in the most convenient position regardless of the arrangement of the steam piping.

Surrounding the upper end of the valve stem is a coil spring H, which acts as a cushion for the valve and stem, and by the use of this spring, the stem can be much smaller, which reduces the friction in the stuffing-box to a minimum. The tension of this spring is sufficient to firmly seat the valve, but if excessive pressure is exerted on the piston, which is often the case when two or more pumps are connected to the same mains, the spring will be compressed, allowing the sleeve to slide down on stem, thus relieving the valve of the increased



Renewable Valve and Seat.

strain, which would be liable to injure it or buckle the stem.

The valves and seats in the Carr Pump Governor are renewable, and all the tools necessary to remove the seats are a wrench and a flat piece of iron wide enough to span the lugs on top of the upper seat. The upper seat is threaded and screwed into the upper opening in valve chamber. The lower valve seat is fitted into the lower opening, making a steam-tight fit, but is free to move sufficiently to compensate for the expansion of valve.

It will be seen in the illustration that the bridges which bind the seats together contain about the same amount of metal, and are of the same length as the post that binds the

valve discs, thus insuring a perfectly tight valve under any steam pressure, as the expansion is the same, regardless of the temperature of the steam. For the reasons given, this governor is especially adapted for fire and water works pumps.

It will be seen that the cylinder is so located that it is perpendicular and parallel to the valve chamber and is not exposed to intense heat arising from the heated parts of the governor and steam piping. With this arrangement, the cylinder naturally remains much cooler than it would if placed directly above the valve chamber, and as the water from the discharge pipe enters the cylinder from the lower end and beneath piston, what little leakage that may be around the piston simply answers as a lubricant and prevents the air from coming into contact with the piston packing.

One of the advantages of this governor is the fact that the inlet from the discharge pipe being at the bottom, the cylinder cannot lime or become rough, thus preventing the governor from working. It is a well known fact that a cylinder placed above the valve chamber is exposed to the heat and becomes very hot, and as the water must enter it at the top, the slightest leakage around the piston will cause streaks of lime to adhere to interior of the cylinder, leaving a rough and uneven surface over which the piston must travel, and the governor becomes practically useless for the purpose for which it was designed. In the Carr Steam Pump Governor this is wholly overcome by reason of the inlet being at the bottom of the cylinder.

Stillman-Carmichael Improved Damper Regulator.

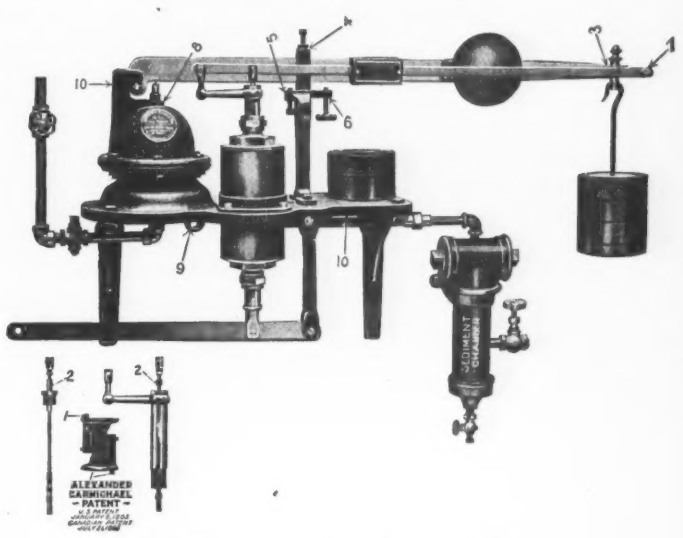
A damper regulator, which embodies all the best features of the older regulators, and upon which many new desirable improvements have been made, is shown in the accompanying illustration. It is manufactured by Stillman & Carmichael, 19 Pearl Street, Boston, Mass.

One of the great advantages of this regulator is that it has the power to move the damper or dampers in both directions by the water pressure and is not of necessity wide open or shut. It will close or open wide the damper on one pound of steam and as it makes a partial stroke, it stands at any point. On account of this positive power in either direction, connection to the damper by chains is dispensed with and no weights are used. That is, it will move from the open position to one-quarter, one-half, three-quarters or any other position and remain at rest and then return to the open position, giving a correct movement of the damper.

Among the many improvements, the interlocking ports insure absolute coincidence of position of the vital parts and avoid all danger of misplacement of the holes in the cup packings and in the flanges, also the mischief of the cup packing dilating and covering the ports. The interlocking tubes continue through all the parts named, thus giving the water pressure free action on the valve and piston at all times, causing it to move instantly with the slightest change of steam pressure.

Another improvement is a new valve stem release, which obviates the dismantling of the top of the regulator to get the valve stem out to be examined, cleaned or oiled. When water is used containing substances that tend to adhere to the valve, this improvement makes it easy to take out and oil the valve, thus preventing the valve and body from being cut. Still another improvement is the arrangement by means of which the regulator will always have its full power from the water pressure because no water can escape except as it exhausts in the proper working of the regulator.

Referring to the accompanying cut, the numbers represent the different improvements made. 1. Patented interlocking ports, preventing by the insertion of brass tube, the misplacement of the holes in valve port, cup packing, and flange, at the same time preventing the closing of the hole by the dilation of rubber and canvas composing the packing. 2. Patented valve stem release, obviating disarrangement of the top of the water motor, to take out the valve stem and valve for cleaning and oiling, these two being patented by A. Carmichael, January 6, 1903. 3. A positive or fixed place on end of back lever for weight hook and weight, as shown herewith. 4. Check nut on set screws. 5. Change of position of set screw, making it easy of access. No S-wrench is now required



Stillman-Carmichael Improved Damper Regulator.

for it. 6. Smaller and quicker closing rod in a more convenient place. 7. Lever connecting bolt of rolled steel in place of brass. 8. More space around top of dome for post of diaphragm pressure cap, thus lessening chance of friction by the impinging of the post on surrounding metal. 9. A changeable bottom post. Can be made right or left hand to suit circumstances. Bottom lever need not now be reversed and off-set used. 10. Strengthened post of diaphragm dome and also increased ribs underneath the shelf.

One of these regulators will govern from one to twenty boilers by moving as many individual dampers or one or more main dampers. They are used for regulating high and low pressure steam boilers, stokers, blower and pumping engines, paper drying machines, elevator pumps and pressure valves.

Improved Type of a Well-known Pump for Operating Hydraulic Elevators.

That your elevator pump does not give you any trouble by stopping is not in itself a good reason for considering it the best that you could employ on the service. In fact, it would

be a better machine if it did stop when the elevators to which it is connected stop, and then start up promptly as soon as the regulating valve acted. There is a great waste of steam caused by elevator pumps running along when the elevators are not in operation and another usual condition that causes great loss is the short stroking of the pump, which means making

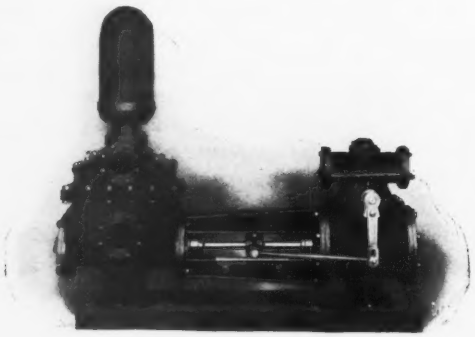


Fig. 1. Standard Davidson Pump for pressure and elevator service.

a shorter stroke than that for which the pump was designed. This short stroking in a machine that often is designed for a length of stroke much less than the diameter of the steam cylinder is very wasteful, as it adds enormously to the clearance space and increases the number of strokes required to deliver a given quantity of water. A well proportioned length of stroke, a positive valve motion that will start promptly at any time and always make full stroke and a water piston with hydraulic leather packings giving full displacement and holding pressure when pump is stopped, are the fundamental features of the Davidson Pump, which especially fit it for

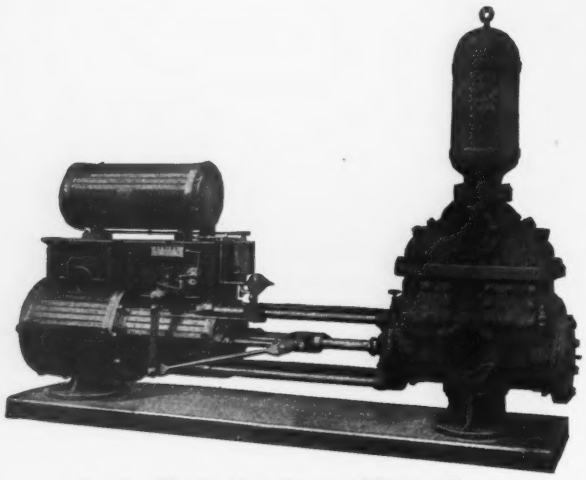


Fig. 2. The Davidson Compound Elevator Pump.

elevator service and which have recommended it to its users for the past twenty-five years.

In the improved Davidson Compound Elevator Pump, shown in Fig. 2, the steam cylinders are properly proportioned to secure the best economy and the pump will start promptly with full power of both steam cylinders when the regulator acts with practically no loss of water pressure. This is accomplished by means of a receiver shown on the top of the steam cylinders.

In ordinary compound elevator pumps, the high pressuure cylinder alone moves the pump for the first stroke after steam has been admitted, as there is no steam in the low pressure cylinder until the high pressure has exhausted into it, therefore the high pressure cylinder on a pump that is starting and stopping must start the load alone, and to do this it must be proportioned of large size or allow a great drop in water pressure. The improved design of Davidson Compound Elevator Pump illustrated herewith overcomes this.

The illustration of the separable duplex pump, shown in Fig. 3, represents the most important improvement that has been made in direct acting pumps and consists of a patented arrangement whereby two independent Davidson Pumps are so fitted and connected that they operate as a perfect duplex machine and permit of either side being shut down and the other side run as a single cylinder double acting pump. Either side may be run as a single pump or both as a duplex machine

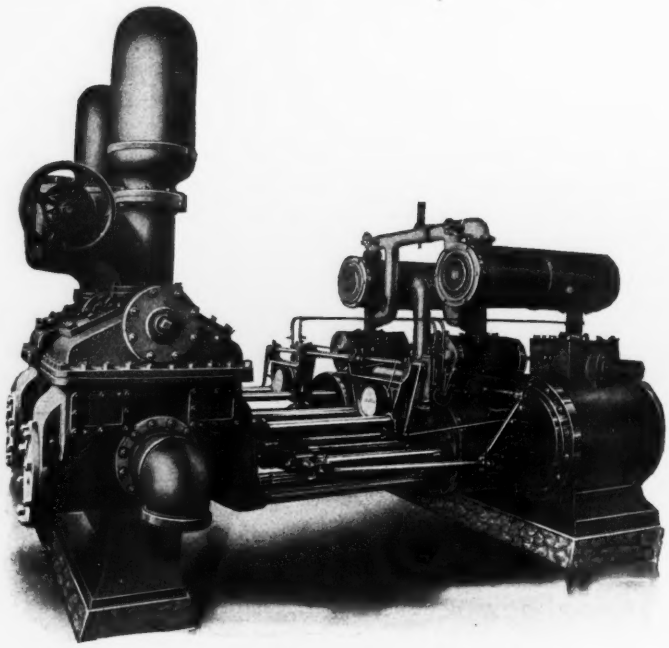


Fig. 3. The Davidson Separable Duplex Elevator Pump.

as long as may be required and the change can be made by simply operating a valve on each side and without interruption to the service.

The works of M. T. Davidson, the manufacturer of these machines, are located at 43-53 Keap Street, Brooklyn, N. Y.; the New York City office is at 141 Broadway, and the New England office at 30 Oliver Street, Boston, Mass.

—o—

Ink for Marking Polished Metallic Surfaces.

The *National Druggist* gives the following for marking polished metallic surfaces: Rosin, 20 parts; alcohol, 150 parts; borax, 35 parts; methylene blue, 1 part; water, 250 parts. Dissolve the rosin in the alcohol and the blue in the solution. Dissolve the borax in the water and mix the solutions. Any other color may be substituted for the blue,—nigrosin, for black, eosin, for red, etc. Use sufficient to mark plainly and legibly.

For Secretaries of Engineers' Associations.

The cut herewith illustrated shows The Monash No. 6 Perfected Duplex Lock Shield Automatic Steam Air Valve, mounted on a stand as a paper-weight. This open sample, nickel-plated with stand oxidized bronze-plated, will be sent

Monash Duplex Air Valve.

free of charge to any association who has room for it in its exhibition case, if the secretary of any lodge of steam engineers, who have not as yet received one, will send his address at once to the Monash Younker Co., 206 South Canal Street, Chicago, Ill.

Could Not Give It Up.

Mr. J. A. Barnett, Rockford, Ill., writes: "Please pardon me for not remitting earlier for renewal of my subscription. I could not give up 'The Practical Engineer.'"

Compression.

One of the objects of compression in a steam cylinder is to furnish a cushion or a gradual increasing resistance, in order to bring the moving parts to rest and change the direction of the push upon them without shock. Another advantage is the filling of the clearance space with steam that would otherwise be wasted, thus reducing the loss from clearance.

Approximate Weight of Water in Pipes.

A pipe one yard long holds as many pounds of water as the square of its diameter in inches; thus a 4-inch pipe holds 16 pounds of water for each yard of length.

Book Review.

Self-Propelled Vehicles.—A practical treatise with illustrations, by J. E. Homans, A.M., 8vo, pp. 672, bound in black vellum, gilt top, gold titles. Theo. Audel & Co., Educational Booksellers, New York. $2.00.

In presenting the new edition of this work, the publishers announce that the book has been thoroughly revised, and in large part rewritten. There is a vast amount of useful information packed into its 644 pages, and it is so well arranged and so clearly stated that the reader cannot fail to find and comprehend the information given.

The general principles of automobile construction and operation, including steering devices, underframes, wheels, tires, bearings, lubricators are included in the opening chapters. Then follows an exhaustive account of the theory, construction and operation of gas engines, occupying over 100 pages. Several typical engines are taken up and discussed separately, and their properties, as regards balance, speed and power, are discussed in the light of fundamental principles. The explanations of the governing devices are clear and valuable, while the discussion of ignition, including the hot-tube, and the primary and secondary sparks, cannot fail to prove of the utmost value.

The book closes with a chapter on "Gasoline Vehicle Management," excellent for its completeness and "useful hints"; another on gasoline cycles that covers the general principles involved in this type of motor. An exceedingly full index at the close of the book puts its contents into "ready reference" shape, an advantage of no small importance in view of contingencies sometimes happening in the use of the 'mobile.

In Memoriam.

At a regular meeting of Progress Council, No. 13, American Order of Steam Engineers, the following Resolutions were adopted:

WHEREAS, It has pleased the Almighty God to remove from our midst our brother member, and

WHEREAS, It is just that fitting resolutions of his many sterling qualities he had, be passed, therefore be it

RESOLVED, By this Council, while we bow with humble submission to the will of the Most High, we do not the less mourn for our brother member who has been taken away from us;

RESOLVED, In the death of Brother Henry M. Fritz we lost a member who has always been ready to offer the hand of aid to this Council and its members, whose utmost endeavors were exerted for its welfare and prosperity, a friend to all, and an upright and honorable citizen.

RESOLVED, As a mark of esteem and appreciation in which we held our departed brother, that our charter be draped in mourning for a period of 30 days, and a copy of these resolutions be spread on the minutes of this Council, and a copy be sent to our official Journal, and to the daily papers, and also a copy be presented to the bereaved family.

HIRAM M. TROUT,
FRANK S. MILLER,
AUGUSTUS B. HESS,
Committee.

October 1, 1904.

Mr. Fritz was a charter member of Progress Council and was its treasurer from the time it was instituted until about a year ago, when he resigned on account of illness.

TRADE NOTES

Stephenson Mfg. Co. are in receipt of a letter from L. Petersen, manufacturer of sash, doors and blinds, of St. Louis, reading as follows:

"Gentlemen: Please send me 30 bars of Belt Dressing, the same as those bought from you Aug. 21, 1902. I have been using other dressing since then, but find your Belt Dressing the best."

If you will write the Stephenson Mfg. Co., of Albany, N. Y., they will very gladly send you a free sample of their Belt Dressing—enough to make a practical demonstration of its worth and value to you.

How to install and operate a Buckeye Boiler Automatic Boiler Cleaner is interestingly told in a fine new catalogue just issued by the Buckeye Boiler Skimmer Co., Toledo, Ohio. This catalogue contains 32 pages and cover, printed in colors on coated paper, and is chock full of illustrations and useful information about automatic boiler cleaners. One important feature in connection with this cleaner is the floating skimmer, the position of which is regulated by the height of water in the boiler. This is accomplished by an ingenious re-grinding flexible joint and copper float, both of which are fully described and illustrated in the catalogue mentioned above. A copy of this catalogue will be mailed upon request to any of our readers.

The export trade of the Burt Manufacturing Co., of Akron, Ohio, is certainly one to be proud of. They have recently sent six Oil Filters to supply their trade at St. Petersburg, Russia, and 27 Oil Filters and Exhaust Heads to their agency at Genoa, Italy, as well as a shipment of 12 Exhaust Heads and three Oil Filters to their Agency at Malmo, Sweden.

Bare steam pipes or those that are insufficiently protected are the agencies through which a great deal of fuel is wasted and through which lots of trouble is created for the engineer. Steam users who are unfortunate enough to have any pipes, boilers or feed-water heaters without insulation should take care of them before the cold weather sets in. Any good covering will pay for itself times over in the saving of fuel alone, to say nothing of the accidents and trouble thus averted. The Norristown Covering Co., Norristown, Pa., announce that they are prepared to fill orders promptly at very low prices.

That the best is the cheapest and most satisfactory in the long run is beyond dispute as far as lubricants are concerned. This is proved in the wide demand for Albany Grease, of which Messrs. Adam Cook's Sons, 313 West street, New York city, are the only makers. R. O. Cumback, superintendent of the Pedrick & Ayer Co., Plainfield, N. J., writes that they have been users of Albany Grease for some time, "and think it is one of the best brands of grease on the market," while the Woodman Cook Co., of Portland, Me., state in a recent letter to the manufacturers that they are using Albany Grease with "entire satisfaction." This well-known lubricant is a favorite one with engineers, and can be used with equally good results on either slow or fast running machinery.

Business has been particularly good of late with T. T. Burchfield Co., Sixteenth and Chestnut Streets, Philadelphia. They have installed a 200-H. P. four-valve engine together with boilers, pump and heater, at the electric light plant at Dover, Del.; a 160-H. P. four-valve engine at the electric light plant at Danville, Pa.; a 160-H. P. four-valve engine at the Berry Building, Philadelphia, making the fourth engine for this latter plant; and also a 600-H. P. four-valve engine for the Colemanville Water and Power Co., including 600-H. P. water-tube boilers, pumps and heater.

The National Equipment Co., Holland Building, St. Louis, Mo., have issued their Steam Bulletin No. 11, which is devoted to the Branch Steam Trap and to Branch National Boiler Compound. Copies will be mailed to those interested upon request.

James McCrea & Co., Chicago, manufacturers of steam specialties, report a very satisfactory demand for their H. H. Steam Trap, which was placed on the market by them three years ago, the trap having been well introduced in the West when they purchased it.

They claim it is the most simple in operation of any trap manufactured, adaptable to both high and low pressure, and each one sold with a guarantee of absolute satisfaction.

Crane Self-packing Globe and Angle and Radiator Valves are illustrated and described in a neat "folder" just issued by the Crane Company, Chicago, Ill.

The Holmes Metallic Packing Co., Wilkesbarre, Pa., have sent us a copy of their catalogue containing many cuts of engines of various types which are equipped with Holmes Packing. We presume that a copy of this catalogue will be furnished to readers of "The Practical Engineer" upon request.

The manufacturer who contemplates installing motors for driving his machinery or machine tools, either individually or in groups, will find much valuable information on the subject in a paper recently read by Mr. Charles Day before Section "B" of the International Electrical Congress recently held at St. Louis. Mr. Day is a member of the firm of Dodge & Day, engineers. The subject is one to which they have devoted much time and study. The large number of motor layouts this firm has made in the past few years and the installations they have engineered has given them a wide range of experience. The paper will probably be reprinted and can be had upon application to Dodge & Day, Philadelphia, Pa.

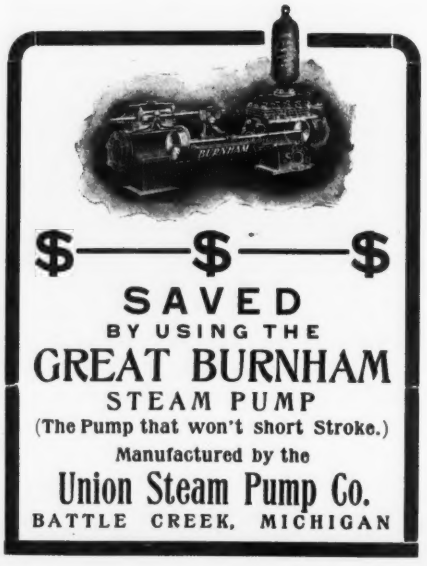
It's free—a 96-page booklet published by the Lake Erie Boiler Compound Co., Buffalo, N. Y. Send a postal card for one before they are all gone.

The Rich Handy Drawing Board is just what its name implies, a handy little drawing board made especially for engineers who only do a limited amount of drawing, though equally valuable to any one where time, space and convenience are to be considered. It is made by J. & G. Rich, 120 North Sixth Street, Philadelphia. A circular showing cut and describing its usefulness will be sent upon request.

H. B. Underwood & Co., 1025 Hamilton Street, Philadelphia, are giving out a mighty useful little advertising novelty in the form of a key ring with celluloid identification tag attached. One of these will be mailed free to any engineer who will send his name and address to Messrs. Underwood & Co.

The Jury of Awards of the Louisiana Purchase Exposition, at St. Louis, have given the gold medal for Boiler Tube Cleaners to the Lagonda Manufacturing Company, Springfield, Ohio, the manufacturers of the well-known Weinland or Lagonda machines.

The users and friends of Weinland cleaners will congratulate the company on this further evidence of the merit of their machines.



Special Catalogue No. 100 has just been issued by the Crane Co., Chicago, Ill. It contains 94 pages 6¼x10½ inches and is devoted to Crane's Pop Safety Valves, Water Relief Valves, Cylinder Relief and Snifting Valves, Hydraulic Relief Valves and numerous other specialties manufactured by the Crane Co., such as Globe, Angle, Straightway and Check Valves; also Steam Gauges, Water Columns, Steam Whistles and other boiler trimmings. A copy of this useful catalogue will be mailed to readers of "The Practical Engineer" upon request. Address Crane Co., Chicago, Ill.

Dewitt W. Smith, Philadelphia representative for the Atlas Engine Works, has removed his offices from 15 North Seventh street, where he has been located for many years, to 704 Arch street.

The Sims Co., Erie, Pa., inform us that business is exceptionally good with them; so good, in fact, that they are working their entire force overtime to fill orders. This is good news. We hope the improvement will be general.

John R. Livezey, sales agent for Nonpareil Cork Pipe Covering, 1936 Sansom street, Philadelphia, has recently closed some very large contracts both in and out of Philadelphia. Mr. Livezey now employs the largest force of men engaged in this line of business in the city, which fact is of itself an excellent indorsement of Nonpareil Cork as a high-grade insulator.

The Cherry Chemical Co., 1215 Filbert street, Philadelphia, have just recently celebrated their eleventh anniversary. During these eleven years the company have manufactured and sold a very large amount of Red Seal Boiler Compound, and their business is still growing. This compound is made in powder form and is delivered to the boiler through the pump or injector after being dissolved in water. The company guarantee satisfaction in every case or no pay.

Dodge & Day, engineers, Philadelphia, Pa., have just been commissioned by the Conkling-Armstrong Terra Cotta Co., makers of architectural terra cotta, to engineer the rebuilding and re-equipping of their plant at Wissahickon avenue and Juniata street, Philadelphia, Pa., lately destroyed by fire.

Pony Catalogue No. 44 is the latest catalogue just issued by Dean Bros., of Indianapolis. It contains some valuable information about pumps. Write for it.

Economy is the subject of greatest interest to almost every engineer. An old and very good engineer recently said to the writer that in nine steam plants out of ten the greatest economy could be effected in the fire-box. In this connection the Boiler Door Arches made by McLeod & Henry, Troy, N. Y., should be interesting. Write for booklet if you are interested.

William Milligan, 726 Sansom street, Philadelphia, now has the agency for the Spencer Damper Regulator for Eastern Pennsylvania, New Jersey, Delaware and Maryland. Mr. Milligan is well known as Philadelphia's leading steam fitter and is a favorite with the engineers. The Spencer Regulator is equally well known, so the connection is a good one.

The Burt Manufacturing Co., Akron, O., have recently received the following orders: from The Jones & Laughlin Steel Co., a 30-inch exhaust head for their plant at Pittsburg, Pa.; from The American Ship Building Co., a second order for Cross Oil Filters, for their yards at Lorain, O.; a cable order from Paris, France, for a large shipment of Cross Oil Filters; from a large plate glass factory at Alexandria, Ind., an order for three 16-inch exhaust heads.

JUST WHAT YOU NEED,

A New Book on Injectors. Their Construction Care and Management, 84 Pages, 45 Engravings, 16 Tables, By Frederick Keppy, M. E. I will send you a copy of this valuable Book on receipt of 25 cents in postage stamps.

F. KEPPY
108 Park Street, Bridgeport, Conn.

TO THE ECONOMICAL
plant operator the
CROSS OIL FILTER

is a most important accessory. It reduces a necessary expense—oil—one-half.

"The Cross Oil Filter give good satisfaction in every case"—Providence, (R. I.) Engineering Works.

The Cross Oil Filter is sent anywhere on thirty days trial.

THE BURT MFG. CO.
Largest Manufacturers of Oil Filters in the world.
204 Main St., Akron, Ohio, U. S. A.
Also supplied by Oil Companies, Engine Builders, Dealers, and Power Contractors.
FAIRBANKS CO.
Sole Agents for Philadelphia.

ANY good hand pump readily delivers Dixon's Flake Graphite, mixed with oil, to a valve, no elaborate devices or expensive changes are necessary.

The application of Graphite is as simple as its effect is marvelous.

To know Dixon's Graphite is to swear by it.

Send for Booklet 96—C. and learn all Dixon's Flake Graphite can do for YOU.

JOSEPH DIXON CRUCIBLE CO.
Jersey City, N. J.

Cochrane Receiver Separators

Have you installed additional pumps or engines since putting in your present lines of steam piping? Has your demand for steam reached the limit or outgrown the capacity of your steam mains? If this is the case, and you have difficulty in maintaining the full boiler pressure at the end of the main, then we would recommend the installation of the receiver type of our Cochrane Steam Separators. These Receivers, which are generally located close to the engine, contain large storage space for steam, and since they provide for the flow of steam through the pipes continuously, instead of only during the period of admission to the engine, they will enable you to pass a much larger supply of steam through your piping than you can at present. By this means they will insure practically the full boiler pressure at the end of the line, and at the same time prevent the hammering and pulsations in the steam pipes which are caused by stopping and starting the flow of steam in the pipe every time the engine valve closes and opens.

Being of the same design as our other Cochrane Steam Separators, these Receiver Separators will insure your engines against damage from an excess of water in the cylinders, besides giving you the full economic value of dry steam.

Our new Separator catalogue **16-S** fully illustrates and describes our Cochrane Separators for every service. A copy is yours for the asking.

HARRISON SAFETY BOILER WORKS
3144 N. 17th Street, PHILADELPHIA, PA.

Manufacturers of Cochrane Feed Water Heaters, Cochrane Steam and oil Separators and the Sorge-Cochrane Systems.

Alphabetical Index to Advertisers

American Injector Co. 57
American Water Softener Co. 42
Atlas Engine Works 60
Audel, Theo., & Co. 61
Baum, The Separator & Machine Co., 55
Borgner, Cyrus 43
Buckeye Boiler Skimmer Co., The.. 38
Burt, The, Mfg. Co. 31
Cancos Manufacturing Co. 46
Carr, E. M. 49
Carr, Joseph 40
Chaplin-Fulton Mfg. Co. 38
Cherry Chemical Company, The.... 47
Continental Chemical Co. 56
Cook's, Adam, Sons 38
Crane, The, Co. .....34 and 47
Crawford, A. 34
Davis, I. B., & Son 53
Davidson, M. T., Co. 38
Dearborn Drug & Chemical Works.. 58
Detroit Lubricator Co. 33
Direct Separator Co. 55
Dixon, Joseph, Crucible Co. 31
Fearon, E., & Co. 43
Federal Valve Co. 48
Foster Engineering Co. 43
France Packing Co. 1
Frick Company 60
Garlock Packing Co. 50
Gem Manufacturing Co. 36
General Engineering Co. 43
Gould Packing Co. 43
Greenwald Co., Henry 32
Guenther & Co., A. W. 36
Haines, William S., Co. 48
Harrison Safety Boiler Works 31
Homestead Valve Mfg. Co. 33
Huyette, Paul B. .....34 and 56
Indicator Instruction Co. 38
Jenkins Bros. .....Cover
Kelly, Benj. F., & Son 55
Keystone Elevator Inspection and Repair Co. 60
Keystone Lubricating Co. 63
Keppy, F. 31
Kieley & Mueller 34
Knox Co. 36
Knox, Frank H. 42
Kruger, The, & Blind Co. 43
Kutztown, The, Foundry & Machine Co. 56
Lackawanna Pump Works 60
Lagonda, Mfg. Co., The.....36 and 47
Lake Erie Boiler Compound Co. 37
Liberty Manufacturing Co. 36
Lindstrom, John T. .....31 and 49
Livezey, John R. .....Cover
Lonergan, J. E., & Co. 49
Lord, The Geo. W., Co. 51
Lukenheimer, The, Company.....Cover
Main Belting Co. 42
McCrea, James, & Co. .....40 and 49
McLeod & Henry Company 57
Milligan, William .....40 and 39
New Jersey Asbestos Co. 42
Nonpareil Cork Mfg. Co. .....Cover
Norristown Covering Co. 62
Ohio, The, Injector Co. 47
Olds Gasoline Engine Works 57
Patterson, Frank L., & Co. 52
Patterson Manufacturing Co. 61
Peerless, The, Rubber Mfg. Co. 2
Penberthy Injector Co. 56
Pennsylvania Electrical & Railway Supply Co. 46
Pennsylvania Rubber Co. 49
Peters, H. S. 42
Powell, The Wm. Powell Co. 43
Pulver, Peter, & Sons 34
Quaker City Rubber Co. 33
Rainear, C. J., & Co. 43
Rich, J. & G. 43
Reilly & Fearon Co. 41
Robertson, Jas. L., & Sons 59
Ruwell, W. F. 43
Shiller & Co. 41
Simonds, Frank A. 55
Smith, W. Clifford 47
Smith, Kline & French Co. 42
Spon & Chamberlain 47
Stamp, Jno. G. 60
Standard, The, Gasket Co. 46
Standard Steam Specialty Co. 54
Stephenson Mfg. Co. .....2nd Cover, 40
Sterling Pipe and Blower Co. 35
Stewart, The, Heater Co. 53
Stillman G. G. 39
The Practical Engineer 56
Thompson, Richard, & Co. 32
Tulley, Henry C., & Co. 39
Underwood, H. B., & Co. .....44 and 64
Union, The, Steam Pump Co. 30
United States Metallic Packing Co., The 35
United States Mineral Wool Co. 46
Universal Belt and Pulley Regulator Co. 39
Wakeman, W. H. 48
Walsh Packing Co. 40
Watson & McDaniel Co. 34
Watt's, John M., Sons 47
Warley & Co., Thos. C. 33
Warren Webster & Company 53
Wilson, H. B., & Co. 47
Whitlock, The, Coil Pipe Co. 53
Wright Manufacturing Co. 48
Zurn, O. F., Co. 43

Engineers and Firemen

A well selected crew of men with city references for soberity and experience are now registered with us for positions.

For prompt and satisfactory results, phone the

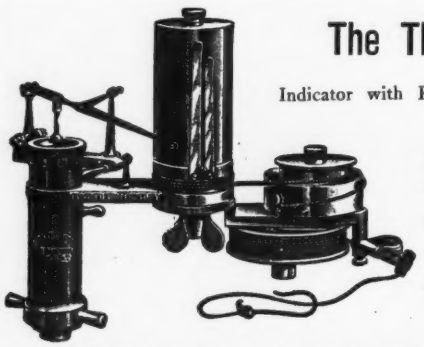
MECHANICAL DEPARTMENT

HENRY GREENEWALD COMPANY

250 South 11th Street, Philadelphia, Pa.

No advance. No registeration fees. We charge for results ONLY that proves the character of this exchange.

BOTH PHONES, (Direct Lines)



The Thompson

Indicator with Reducing Wheel.

We also make Damper Regulators, Tube Cleaners, Shaking, Dumping and Stationary Grate Bars.

Send for Catalog.

RICHARD THOMPSON & CO., Sole Manufacturers

128 LIBERTY STREET NEW YORK, N.Y.

There Must Be Some Reason

WHY

Homestead Valves

are demanded in all four quarters of the globe

We will impart the secret to you. They are higher priced and very much better than the ordinary kind for all *HARD-TO-FILL* places.

Write for Booklet No. 10, just issued.

Homestead Valve Mfg. Co.

Box 1754, Pittsburg, Pa., U. S. A.

Works at Homestead, Pa.

WHY ARE

Warley's Boiler Cleansing Compounds

IMPORTANT TO

Engineers and Steam Users?

BECAUSE

We don't want One Dollar of your money

until we are able to convince you that these Compounds will positively prevent pitting and corrosion and remove and prevent scale or incrustation in your steam boilers, without injury to the metal of the boilers or any of the joints or fittings. Also that these goods do not contain anything of a poisonous nature, and will not pass over with the steam, nor injure any goods that you manufacture, not even food or drink products.

We make a specialty of the hardest and most difficult cases of scaly boilers, and use none but the purest and highest grade of Chemicals in the manufacture of our Compounds. An absolute guarantee given on each package to every new customer.

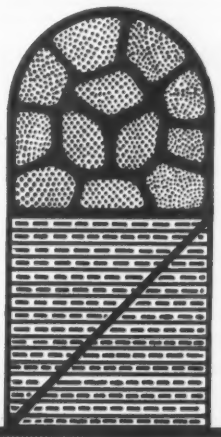
Thos. C. Warley & Co.

MANUFACTURERS

No. 221 S. Front St. PHILADELPHIA, PA.

Call, or write us for book, "Practical Questions and Answers," to prepare for Engineer's License, which is free for the asking.

'PHONE CONNECTION



FIRM FOUNDATION

For our Claims of Superiority for

P. P. P.

Chas. C. Pierson, of Galena, Kan., says P. P. P. saves him work and trouble because it lasts so long.	**P. P. P. saves Work**
P. P. P. saves Power	Chas. M. Johnson, of Milwaukee, Wis., says P. P. P. proved a great economizer in steam.
J. M. Smith, of Louisville, Ky., says P. P. P. saved $95 a year in the cost of packing.	**P. P. P. saves Packing**
P. P. P. saves Piston Rods	C. A. Clark, of New York City, says P. P. P. produces little or no friction and does not cut the rod.

Send coupon today and we will send you photographic copies of the letters of the engineers mentioned above.

Quaker City Rubber Co.

Philadelphia

Chicago

The Quaker City Rubber Co. Philadelphia.

Gentlemen: Please send me your booklet proving that P. P. P. will save work.

Name _____

_____

St. and No. _____

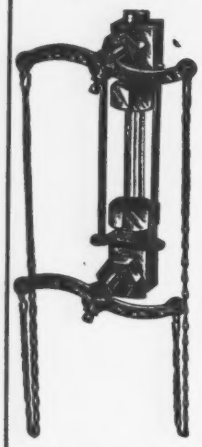
City _____ *State* _____

Occupation _____

Employed by _____

Practical Engineer

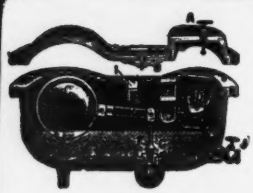
SAVED



BY A
PULL
The "P. B. H."
Quick-Closing
Water
Gauge

A Pull on the Chain Does it.
Strongly Made.
Low in Price.
Sent on Approval.
Satisfaction Guaranteed.
We also make the
"P. B. H."
IMPROVED
GAUGE COCK

PAUL B. HUYETTE
1245 BETZ BUILDING
PHILADELPHIA, PA.



McDaniel Steam Traps
Always have a Water Seal over the valve and never blow steam; neither do they back up water

REDUCING VALVES
EXHAUST PIPE HEADS,
EJECTORS, RELIEF VALVES,
GREASE EXTRACTORS,
STEAM SEPARATORS, etc.

Watson & McDaniel Co.
MANUFACTURERS
Send for 1902 Catalogue
147 N. Seventh Street
For sale by the Jobbing Trade

CRANE VALVES
ESTABLISHED 1855

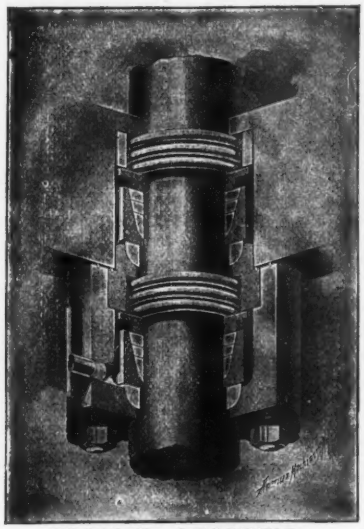
ALGEBRA SELF TAUGHT
The Best Book for Young Engineers. Commencing from the very beginning and going step by step from one stage to another, simply written, easy to follow and soon understood. FREE for a club of 3 subscribers to THE PRACTICAL ENGINEER at 50 cts. each.

Steam Coal a Specialty
Telephone Connection 2-25-64
A. CRAWFORD COAL
1829-1833 N. Tenth St., Philadelphia, Pa.

GETTING
Subscriptions
FOR
The Practical Engineer
is easy, it pays too, and moreover you have the satisfaction of knowing that you are giving each subscriber the best value that he ever purchased for fifty cents.

The Practical Engineer is admitted to be the largest and best engineers paper ever published anywhere in the world for fifty cents a year.

U-NEED-A CLIMAX DAMPER REGULATOR
MANUFACTURERS OF
Reducing Valves and Steam Traps for all services, Damper Regulators, Back Pressure Valves, Relief Valves, Boiler Feeders. Grease Extractors, Steam Separators, Float Valves, Hot Water Tank Temperature Controllers, Water Feeders, Tank Pump Controllers, Water Arches, Pump Regulators, Waste Heat Utilizers, Automatic Receivers and Pump Regulators, Combination Muffler Tanks, Grease Extractors, etc.
WRITE FOR CATALOGUE.
KIELEY & MUELLER
34 West 13th Street, NEW YORK CITY
JAMES J. BROGAN, 810 Race Street, Philadelphia, Pa.



CLASS No. 1 PACKING

UNITED STATES
Piston Rod and Valve Stem
PACKINGS

Do their work well.
Their use will save you considerable money and endless trouble.
We can present convincing proof of their worth.

SEND FOR CATALOGUE AND PRICES

The United States Metallic Packing Co.

MAIN OFFICE AND WORKS:

509 Great Northern Building
CHICAGO. ILLS.

No. 427 North Thirteenth Street.
PHILADELPHIA. PA.

Dirty roofs and walls give your plant an unbusiness like appearance.
Neatness in this respect can be secured at a comparatively small expense.

The Sterling Exhaust Head
Will do it Perfectly

No back pressure on your engine.
All the water and grease in the steam entrapped and drained to any desired point.

WE PREPAY THE FREIGHT.
YOU RETURN THE HEAD IF NOT AS REPRESENTED

Sterling Pipe and Blower Company

HARTFORD, CONN.

There's Always a Best Machine

In every line. One that everybody recognizes as standard, Among Tube Cleaners is

The WEINLAND

No. 8 TURBINE, Patented.

This Cut shows Our No. 8 The King of Turbine Cleaners

We have others, Hand Cleaners and Power Driven Cleaners—all kinds and sizes for all styles of boilers and all sizes of tubes. Get our catalogue of Tube Cutters, Damper Regulators and etc.

The Lagonda Co. Springfield, O.

RUGGLES IMPROVED FLUE CLEANER

The best Device on the market to-day for the cleaning of Smoke Flues.

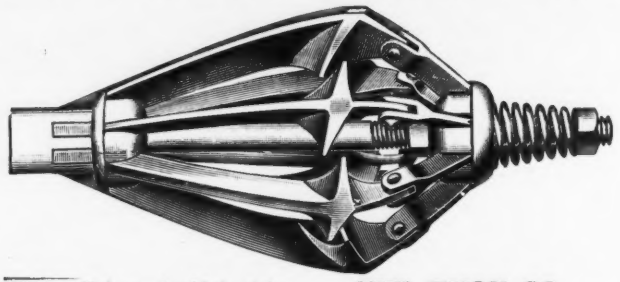
This Device is so constructed that it adjusts itself to variations in diameter of Tubes, thoroughly cleans all spots, does not catch on its withdrawal, and effectually overrides all uneven surfaces. This Cleaner will not loose its temper by using it in hot Tubes and is just as efficient for hot or cold Tubes.

Write for booklet. Liberal discount to the Trade.

Sole Manufacturers A. W. GUNTHER & CO. Milwaukee, U.S.A.

Philadelphia Agents:—SCHADE & MARSHALL, 142 N. Sixth St.

The PHOENIX BOILER FLUE CLEANER



Has six self sharpening blades doing perfect work, and in spliced flues

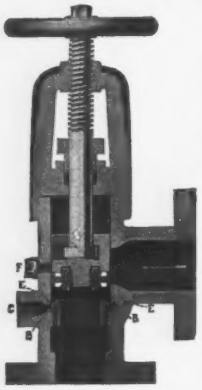
THE KNOX CO.
Reading, Pa.

Boiler Tube Cleaners Blow-off Valves

The Liberty Turbine Boiler Tube Cleaner

will clean tubes more thouroughly, at less cost, and in less time than can be done by other means.

This we guarantee.



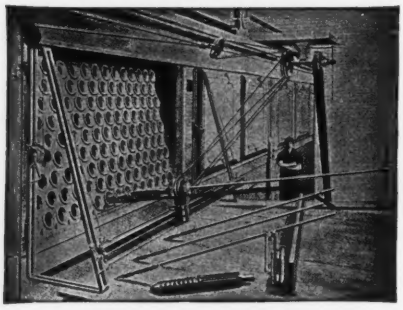
We also make the **Niagara Turbine Tube Cleaner.** We have suit for infringement of patents against a user of the Weinland machine, and will sue all other infringers

The Faber Blow-off Valve washes its face every time it is opened and closed.

A connection at C admits steam at boiler pressure to chamber B, whence it escapes through slot E all around the seat, and sweeps both seat and disk free from sediment just before closing. It will last as long as a steam valve without leaking.

Liberty Manufacturing Co.

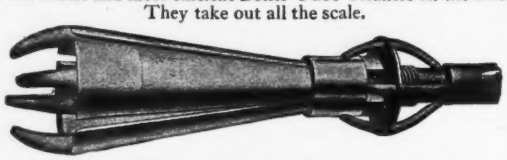
6907 Susquehanna Street - Pittsburg, Pa.



The Union Boiler Tube Cleaners

POWER OR IMPULSE

Are the oldest and most efficient Boiler Tube Cleaners on the market. They take out all the scale.



The Gem Flue Scraper

does the same for Smoke Flue Boilers

We also make **Gem Oilers,** Patent or Plain, **Torches and Heavy Brazed Steel Oilers, Flexible Shafting, Loose Pulley Lubricator.**

Write for Catalogue and Prices.

Gem Manufacturing Co.

Spruce near 33d Street - Pittsburg, Pa.

TWO GOOD BOOKS, FREE

Algebra Self-Taught

By W. P. HIGGS

This is a most excellent book that commences at the very beginning and goes step by step from one stage to another. It is simply written and easily understood.

Every young engineer should have one of these books. The study of Algebra is intensly interesting and a knowledge of it is a valuable possession.

Ammonia Refrigeration

A practical handbook for engineers in charge of ice plants. It is fully illustrated and contains numerous tables. The tables alone are worth the price of the book for reference purposes. It is fully indexed so that any detail may be found at a glance. It is in plain and comprehensive language and is printed in large clear type.

Either of the above books will be given free for a Club of Three Annual Subscriptions to The Practical Engineer at Fifty Cents Each, or both of them for Six Subscriptions.

One copy of either book and One Year Subscription for One Dollar.

This is an exceptional opportunity, and every engineer should take advantage of it while the books last.

We and our predecessors have made Red Star Boiler Compound for over twenty years.

We have done nothing but make Red Star, except to sell it. We have had many and various experiences with different conditions. Sometimes we have made mistakes. These we have profited by.

Other times we made successes. These we have adopted and improved.

To-day we can say that we know the boiler compound business up to date. Next year we will know more, if there's more to know. Now and at all times the benefit of our experience is yours for the asking.

Send for our new 96 page booklet. IT'S FREE.

LAKE ERIE BOILER COMPOUND CO.

CHICAGO STREET BUFFALO, N. Y

BRANCH OFFICES

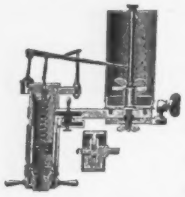
NEW YORK CITY
171 Broadway

PITTSBURG
326 Fourth Avenue

CINCINNATI
70 Mitchell Building

KALAMAZOO
210 S. Pitcher Street

INDICATOR FREE



With our course of Indicator Instruction and you have the instrument—A GOOD ONE, TOO, while you are learning—you can pay all cash, or you can pay $5.00 down and $5.00 per month, just as you please. The course is thorough, from "A to Z," and when completed, you get a handsome diploma. Write for prospectus and free pocket case of 6 accurate indicator scales. We have an office in Boston and St. Louis, and after October 1st will have one in New York, Newark, N. J. and Philadelphia. Our representative will call if you invite him. Special offer for October. Address

Indicator Instruction Co.

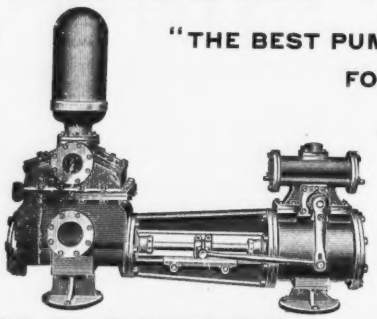
190 FRANKLIN AVENUE

SCRANTON, PENNA.

DAVIDSON PUMPS

"THE BEST PUMP BUILT"

FOR ALL SERVICES



Finest Mechanical Design and Construction

Material and Workmanship first class in every respect.

SEND FOR CATALOGUE

M. T. DAVIDSON 141 Broadway, New York

There is only ONE

ALBANY GREASE

and we are the only makers

LUBRICATES EVERYTHING

Adapted to all kinds of machinery

Cost of using oil

Cost of using Albany Grease

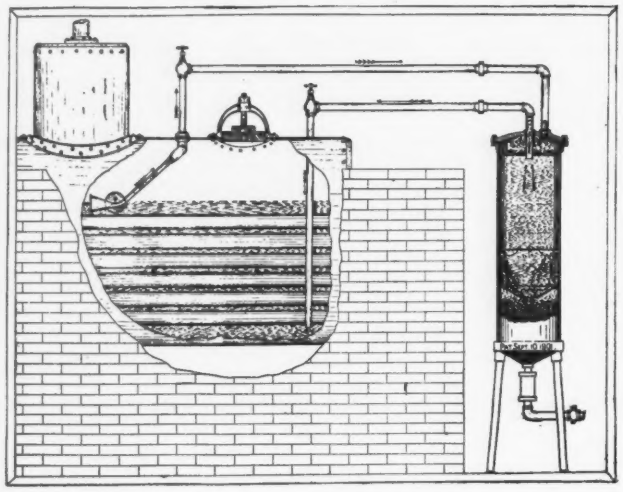
Remember, a sample can of Albany Grease with an Albany Grease Cup free of charge or expense for testing.

The only information necessary to send is, pipe connection in bearing, depth of oil hole from top of cap to journal, and give particular part of machinery on which the same is to be tested.

THIS TRADE MARK ON EVERY PACKAGE. Sold by Engineers and Mill Supply Dealers the World over.

ADAM COOK'S SONS
313 West St., N. Y. City

BOILER EXPLOSIONS



are usually caused by incrustation and corrosion, and sometimes by the use of improper chemicals, which work under the rivets and destroy the seams. If your boiler is equipped with

THE BUCKEYE AUTOMATIC BOILER CLEANER

there will be no scale and no chemicals needed.

Your coal bills will be much less, and your repair bills will be less.

The scale forming matter and other impurities are removed from the water and discharge into a precipitator.

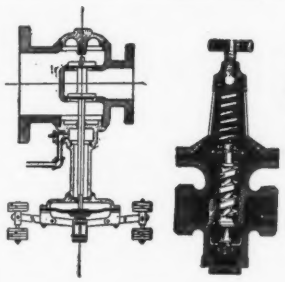
Boiler cleaning time never comes when your boiler is equipped with a "Buckeye."

We install them on trial. **Send for Catalogue.**

The Buckeye Boiler Skimmer Co.

TOLEDO, OHIO

WILLIAM MILLIGAN Phones: Bell-Walnut 1271a Keystone-Main 1-71 726 Sansom Street, Phila., Pa.



Manufacturers' Agents for Philadelphia, representing the

Watts Regulator Co.

Manufacturers of Steam Appliances, Steam Regulators, Water Regulators and Pump Regulators, Steam Traps, Boiler Oil Feeders Reducing Wheels.

SOLE AGENT for Pennsylvania and Southern New Jersey and Delaware for the

STILLMAN-CARMICHAEL IMPROVED DAMPER REGULATOR

(10 IMPROVEMENTS)

Send for prices and circulars as above.

YOU CAN'T LOSE--

Our plan is so simple and fair and square that you can't lose.

Universal Belt & Pulley Reg. Co.
New York

Brooklyn, Mar. 15, 1904.

GENTLEMEN:—The covering which you put on our pulleys at our factory, 28 & 30 Rodney Street, Brooklyn, has proved eminently satisfactory. Prior to its being put on one of the motors which drove the line shafting had to be set at an angle in order to keep the belt on the pulley. Since the application of your covering the motor has been squared up and is running perfectly straight.

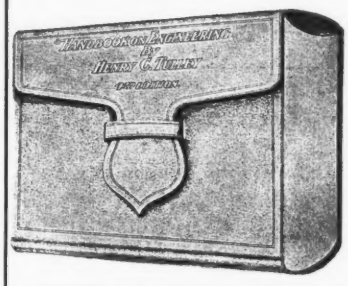
We take great pleasure in recommending the covering.

Yours truly,
WATERBURY & CO.—Per Geo. W. Nock.

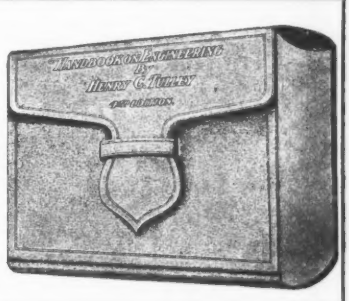
THE UNIVERSAL BELT AND PULLEY REGULATOR

is sold on a thirty day trial. Can anything be fairer than that? **It is guaranteed to last five years. Pulleys re-covered free of charge if worn off before end of time stated.** For either iron or wooden pulleys. It's to prevent slipping too. Send us the size of the pulley you wish to cover and we will give price of work complete.

235 Lexington Avenue, **Universal Belt and Pulley Regulator Co.** **NEW YORK CITY**



WANTED
Chief Engineer
SALARY $1800 PER YEAR



What sort of men, do you suppose, land jobs like that? The answer is easy. They go to men who know their business. And how do they learn it? Partly by experience and partly by studing during their off hours instead of fooling away their time. Lots of your friends owe their success to

Tulley's Handbook on Engineering

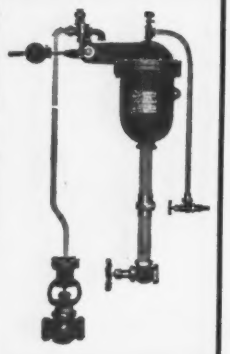
It's a complete library on steam and electrical engineering, refrigeration, elevator work, etc.—written by an engineer who knows for engineers who want to know. There are 990 pages of solid "meat"—no "froth" no "gas"—just good, straight, salary-raising information. It's yours for $3.50 and you can have your money back if you don't like the book.

TULLEY'S 4th EDITION IS A WONDER IN ELECTRICAL AND MECHANICAL ENGINEERING

Henry C. Tulley & Company

Room 402 Wainwright Building

ST. LOUIS, MO., U. S. A.



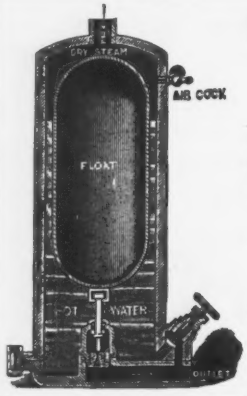
INSTALL THE

Vigilant Water Feed Regulator

THEY WILL PREVENT A DOSE OF WATER IN YOUR ENGINE CYLINDERS.

Let us send you a list of users that you may investigate. Write

CHAPLIN FULTON MFG. CO.
32 PENN. AVE. PITTSBURG, PA.



Remember :—

This is STEAM TRAP season.

If that old trap is wasting steam and not doing its work, replace it with the H. H. STEAM TRAP, and have no more trouble or expense.

We guarantee it to give satisfaction or pay freight both ways.

SEND FOR OUR CATALOG.

JAMES McCREA & CO.
Manufactures
67 W. Washington St., CHICAGO

"Caught with the Goods"

(THE WRONG GOODS)

once But never again

Aug. 26/04. St. L. Mo.

Stephenson Mfg. Co
Gentlemen:- Please send me 30 Bars Belt Dressing, the same as those bought from you Mar 21/1902, I have been using other dressing since then but find your belt dressing the best.

Yours truly
L Petersen per AB.

LAURITZ PETERSEN,
Sash, Doors and Blinds,
S. E. Cor LYON & LYNCH STS.
ST. LOUIS, MO.
2800 Lyon Ste St. Louis Mo.

Write us for free sample.

Stephenson Mfg. Co.
ALBANY, N. Y.

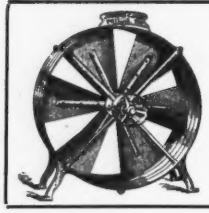
Practical Ammonia Refrigeration

By REDWOOD

A practical American handbook for engineers and helpers in charge of ice plants. Illustrated, cloth. **By mail, $1.00,** or will be sent free as premium for a club of three subscribers to The Practical Engineer, at 50 cts. each, address

THE PRACTICAL ENGINEER

46 N. Twelfth St. Philadelphia



CIRCULATING AND EXHAUST FANS FOR VENTILATING PURPOSES

also Light Pulleys and Hangers for Shafting.

Prices on Application. Send for Circular.

JOSEPH CARR, Manufacturer
132 N. Seventh St. Philadelphia

Walsh Metal Face Packing

A—Fibrous Packing. **B**—Metal.
C—Open space to avoid butting when cover is worn off.
D—Section of metal cut out at C.

Adapted to all kinds of Steam and Water Packing. Will not cut Rods, will not wear rods to shoulder, will not harden under compression. More durable than fibrous packing. Less friction, as it is lubricant of itself. For packing engines, steam hammers, cranes, valves, expansion joints, pumps, elevators, accumulators, hot-water plunger pumps, etc. **Cotton, Linen and Square Flax Packing in Stock.**

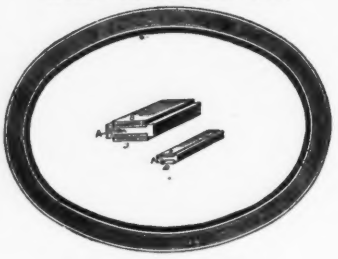
PACKING FOR ELEVATORS a Specialty

Walsh Packing Co.

1118 and 1120 S. Seventh St., Philadelphia, Pa.

Walsh Combination Gaskets

WILL NOT BLOW OUT



Can be used from 10 to 40 times.
The Cheapest Gasket Made.

A—Soft Metal. **BB**—Rainbow Rubber. Composed of Soft Metal and Rainbow Rubber as shown in cut. Made different widths and thicknesses for man and hand hole Gaskets.

W. F. RUWELL

Late with H. B. Underwood & Co.

General Repairs to Corliss, Greene and other Steam Engines.

Cylinders and Valve Seats Rebored in Place

We make a specialty of repairing Ice Machines and Pumps. All work guaranteed strictly first class.

Office and Works.

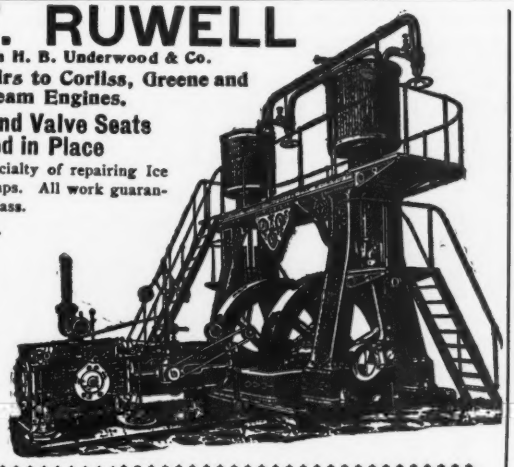
719-721
NOBLE STREET
PHILADELPHIA

—

Tele. Connection

—

We make a specialty of Metallic Packing or Piston Rods.



Telephone **EAGLE IRON WORKS** Established 1851

Reilly & Fearon Co.

Successors to Hoff & Fontaine

MANUFACTURERS OF

Engines, Boilers, Stacks and Tanks

General Machinists' and Iron Founders

1152-1164 NORTH THIRD STREET, PHILADELPHIA, PA.

Complete Power Plants — Steam Fitting — Cylinders Bored in Position

General Repairs to Ice Machinery, Engines, Boilers, Pumps, Etc.

BOTH 'PHONES

E. FEARON & CO.

Engineers and Machinists

110 OXFORD STREET

PHILADELPHIA

Engines, Pumps, Boilers and Electrical Machinery

Textile, Dyeing, Chemical and Paint Machinery

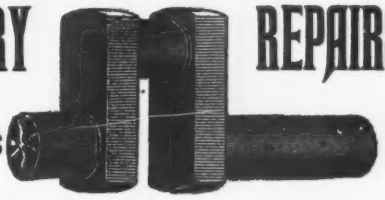
REPAIRING AND JOBBING PROMPTLY ATTENDED TO

James Gemmell Phones—Bell 42-69 D, Keystone 44-65 D

CYLINDERS OF ENGINES AND PUMPS REBORED IN PLACE

MACHINERY REPAIRS

STACKS, TANKS



General Engineering Co.

Engineers, Boiler Makers, Blacksmiths

J. Gemmell, Supt. Phila., Pa. 764 Swanson St.

F. W. SCHILLER W. G. RICE JOS. F. SCHILLER

Schiller & Co., Ltd.

Machinists' and Engineers

Special attention given to repairing, all makes of

STEAM ENGINES & PUMPS

Cylinders Rebored in position by special machinery. Dynamo Commutators and Crank Shaft Journals turned off without removal.

Makers of Special Self-Adjusting Cylinder Packing.

Estimates Given Cheerfully, All Work Guaranteed

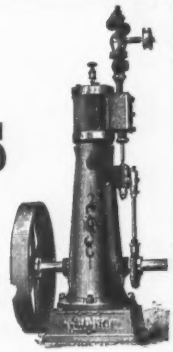
N. W. Cor. 5th and Locust Sts., Philadelphia, Pa.

ESTABLISHED 1871

J. & G. RICH

General Machinists

ENGINE BUILDERS
AND DEALERS IN MACHINERY



Especial Attention Given to Repairing and Erecting Steam Engines, Pumps and other Machinery, Shafting, Hangers, Pulleys, Etc.

120 NORTH SIXTH STREET, PHILADELPHIA, PA.

TELEPHONE

Steam and Gas Engine Repairing

We send Portable Tools and Expert Machinists' to **REBORE** Cylinders, Valves, Ports, Straight and Taper Crank Pin Holes etc., Reface Flat Valves, Turn off Crank Pins.

NEW PISTONS, ALL STYLES, STEAM SPECIALTIES

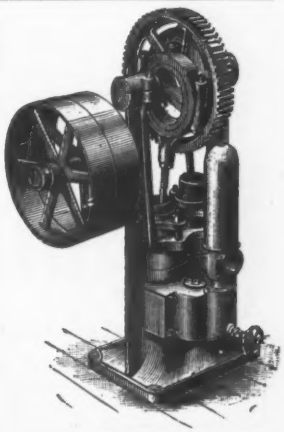
Emergency Repairs, Day or Night

ESTIMATES FURNISHED ALL WORK GUARANTEED

THE KRUGER & BLIND CO., MACHINISTS AND ENGINEERS

KEYSTONE BELL | Telephones

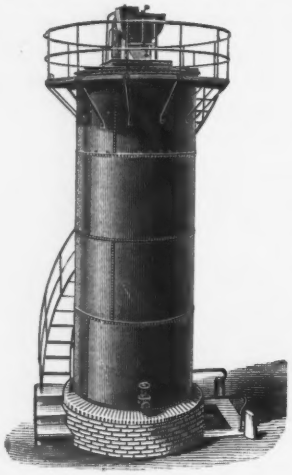
511 and 513 Master Street, Philadelphia



KEYSTONE BELT PUMP

You Don't Drink

impure water if you can get it pure; then why feed your boilers on a water that is going to lead to a youthful grave and to early gray hairs.



The Water softening plant here shown is assuring a long life for the boilers and rendering the lives of the men about them safer and more enjoyable.

We are always happy when mailing our booklet and figuring on a plant.

Western Office

311 Outlook Building, Columbus, Ohio.

AMERICAN WATER SOFTENER CO.,

Harrison Building
Philadelphia

EVERY USER OF POWER AND LIGHT SHOULD READ THE

POWER AND LIGHTING ECONOMIST

tells how to buy best, how to save money, how to improve methods. Thus $1 may save you $1,000. —50c. a copy, $1 a year; Frank H. Knox, Troy, N. Y., and all live newsdealers. Send for great clubbing offer.

BELTING

For Main Driving and General Use
IS A DISTINCT ECONOMY
over any other belting. We will gladly furnish practical proof of this.

MAIN BELTING COMPANY

1219-39 Carpenter St., Philadelphia. 55-57 Market St., Chicago. 120 Pearl St., Boston. 40 Pearl St., Buffalo.

FOR 14 YEARS, THE

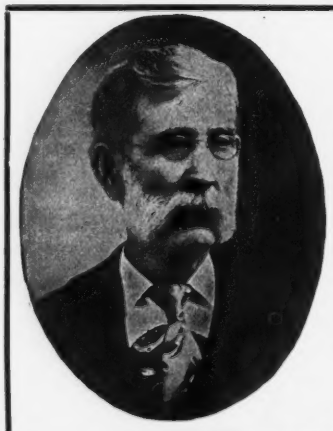
BROTHERHOOD TRADE MARK REG'D OVERALLS

have led all others; have introduced every improvement of value. They couldn't be made better, if you were willing to pay double the price; yet cost no more than those nearest their quality. They do cost more per garment than most kinds, but cost you less **by the year** than any others; that's where economy comes in. Try them; my absolute guarantee holds you safe against loss.

B. L. F. No. 3 **H. S. PETERS** B.L.E. No. 171

Manufacturer :: Dover, New Jersey

THE BROTHERHOOD MAN WHO HAS RAISED THE STANDARD OF OVERALLS THROUGHOUT ALL NORTH AMERICA



J. C. McNELLEY

McNELLEY'S AMERICAN BOILER COMPOUND

Our compound is the result of years of experiments by an engineer of long experience, assisted by expert chemists.

American Boiler Compound not only completely removes all scale and incrustation in the boiler, but prevents new from forming, and will, if properly used, keep the boiler absolutely clean and free from all forms of corrosion, such as pitting, grooving, honeycombing.

Send Sample of Water and Sample of Scale if Convenient.

We will be pleased to hear from engineers who will secure trade for us. When writing for information address

J. McNelley, Dept. Mgr., 35 Poplar St., Phila.

SOLD THROUGH

SMITH, KLINE & FRENCH CO.

429-435 Arch Street, - - - Philadelphia, Pa.

"GLADIATOR" Asbesto-Metallic High-Pressure PACKING

Something Entirely New
SEND FOR SAMPLE

RING

It is not merely a piece of Packing cut the required length and pressed to shape on a mandrel, but is molded in steel dies under hydraulic pressure until it is almost as solid as metal.

They are composed of the same material as the Famous "Gladiator" Asbesto-Metallic Packing.

NEW JERSEY ASBESTOS CO. CAMDEN, N. J.

POWER STATIONS
ARE
MORE EFFICIENT
WHEN
EQUIPPED WITH
FOSTER VALVES

BACK PRESSURE VALVE

CLASS "W" VALVE

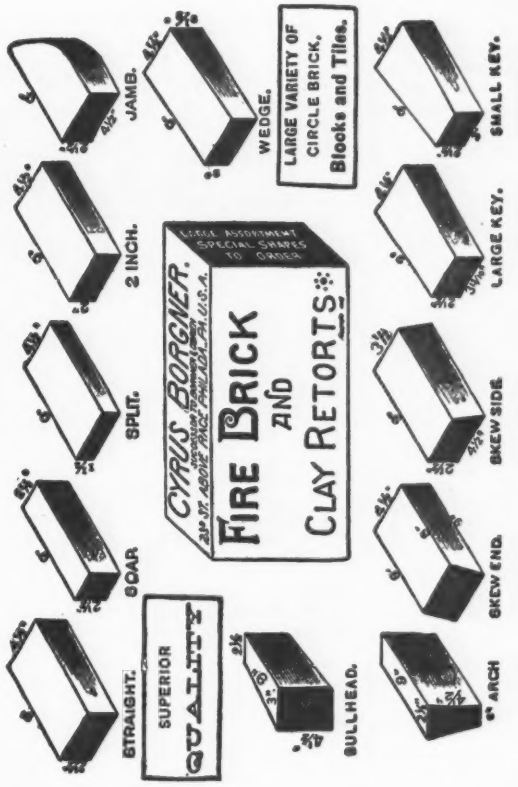
Pressure regulation is an all important consideration in the economics of the steam plant.

A FOSTER CLASS "W" VALVE should be installed in every plant where high pressure is used and fixed delivery pressure is required, for it will add both to efficiency and economy. It has no weights, levers nor pistons; is very sensitive; may be adjusted for pressure desired and, once adjusted, will keep up a constant uniform delivery regardless of variation in boiler pressure.

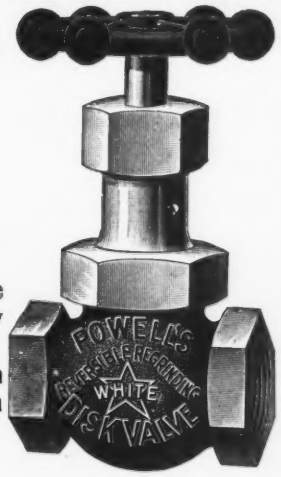
FOSTER BACK PRESSURE VALVE will maintain a constant back pressure without hammer or chatter; no direct-acting springs or weights are used; valve may be readily thrown out of service by a turn or two of a screw bolt, pressure cannot creep up above point of adjustment

For details of these two valves, as well as many other pressure regulating devices, see a FOSTER CATALOG.

FOSTER ENGINEERING CO.
NEWARK, N. J.



POWELL'S
"White Star"
Regrinding
Reversible
Seat Valves



have a longer life and are easier to repair than any valve made.

They are sold with a guarantee of satisfaction or your money refunded.

Try one.

Wrought Iron Pipe
Not Steel

Cut to any size and for any purpose. Prompt Shipments to any part of the world guaranteed

Engineers' Supplies and Steam Fitters' Tools

C. J. Rainear & Co.
No. 518 ARCH ST. - - Philadelphia

O. F. Zurn
J. M. Zurn
J. D. Kelley
C. J. Curran

O. F. ZURN CO.

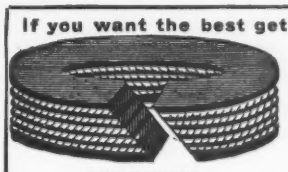
HIGH-GRADE
LUBRICATING OILS AND GREASES

PEERLESS Boiler Cleaning Compounds

Our First and Last Consideration is QUALITY

23 & 25 S. Fifth ST., PHILADELPHIA

If you want the best get Gould's Steam and Water Packing


RING PACKING

In ordering give EXACT diameter of stuffing box and piston rod or valve stem.

See that our name and trademark is on every package.

Gould's STEAM AND WATER Packing

Gould Packing Co.
E. Cambridge, Mass.
Albion Chipman, Treas.

REGISTERED TRADE MARK
East Cambridge, Mass.

DANIEL W. PEDRICK,
MORRIS G. CONDON
ALBERT D. PEDRICK

L. B. FLANDERS MACHINE WORKS.
ESTABLISHED 1870

Sole Makers of
ST. JOHN SELF ADJUSTING
CYLINDER PACKING.

H. B. UNDERWOOD & CO.

GENERAL MACHINISTS,

1025 HAMILTON STREET PHILADELPHIA, PA.

Engines, Pumps *and* Machinery Repaired Quickly *and* Well

The old saying that "a stitch in time saves nine" applies to a steam engine with greater force than to most things, for when an engine is in need of repairs, she not only gets worse very rapidly but she becomes a mighty extravagant servant and soon wastes more fuel than would pay the repair bill. We make a specialty of

Repairing Steam Engines *and* Pumps

WE REBORE CYLINDERS IN PRESENT POSITION FROM THREE INCHES TO 110 INCHES IN DIAMETER

Dynamo Commutators Turned Off Without Removal.
Builders of Dash Pots.
Portable Planer for Facing Off All Sizes of Hammer Blocks in Present Position
Blacksmithing. Steam Power Hammers.
We send Experienced Mechanics with Portable Tools to All Parts of the Country to Repair Engines and Pumps.
Portable Milling Machine for Milling off Valve Seats in Position.
Ice Machine Repairs a Specialty.
Sole Agents for St. John Self-adjusting Cylinder Packing.
Send for Our Book of Useful Hints for Engineers.
Crank-shaft Journals of all sizes turned off without removal.

We Have a Special Machine for Reseating Valves in Position, from 1 to 12 inches in Diameter

WE ALSO MAKE A SPECIALTY OF GEAR CUTTING, INTERNAL AND EXTERNAL, UP TO 36 INCHES DIAMETER

DANIEL W. PEDRICK.
MORRIS G. CONDON
ALBERT D. PEDRICK

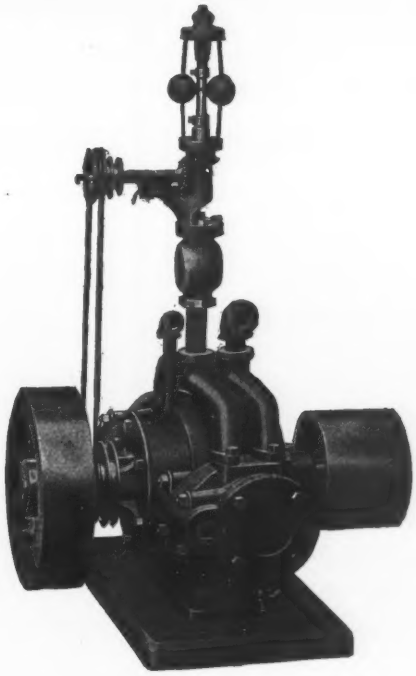
L. B. FLANDERS MACHINE WORKS.
ESTABLISHED 1870

Sole Makers of
ST. JOHN SELF ADJUSTING
CYLINDER PACKING.

H. B. UNDERWOOD & CO.

GENERAL MACHINISTS,

1025 HAMILTON STREET PHILADELPHIA, PA.



Two-Cylinder Steam or Air Motor

For driving special tools and machinery.
Driven by steam or compressed air.
Floor space 19x19 inches, weight 147 pounds. Equal to any electric motor and more economical.
Easily taken apart, easily assembled.
No shop is complete without at least one of these handy little engines.
Can be used for a thousand different purposes, and will save its cost a dozen times a year.

THIS LITTLE MOTOR IS

New, Novel and Mighty Useful

Look at it. Read about it and think about it; perhaps there is a place about your establishment where you can place one to advantage.

Write for circular and price

PHOTOGRAPH OF PACKING TAKEN FROM A STUFFING BOX OF FOUR INCH ROD

The Packing that lasts as long as the Engine

LARKIN'S

SELF-LUBRICATING METALLIC PACKING

Can't blow out or burn—pliable and elastic—reduces friction—will not scratch or corrode the rod—always fits and any body can fit it. It's the handiest, most durable and most economical packing.

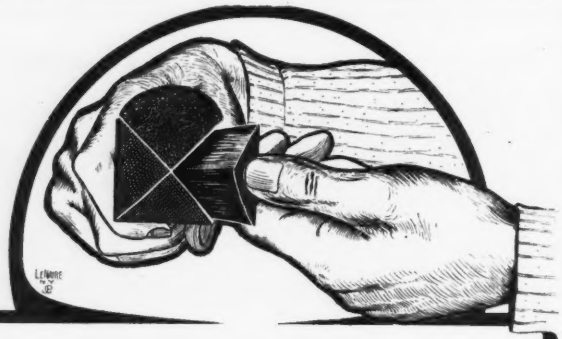
SOLD ON A GUARANTEE. ASK FOR BOOK.

Pennsylvania Electrical & Railway Supply Co.

General Sales Agents

PITTSBURGH, PA., U. S. A.

THE HOLLAND COMPANY, Chicago, Ill., and San Francisco, Cal.
W. G. BEAMER, Beaumont, Texas. E. A. KNOWLTON, Boston, Mass.
A. H. TRUAX, Ripley, Tenn. G. S. GRANNIS, New Haven, Conn.
W. J. SHIVERS, Macon, Ga. A. E. WILLSON, Indianapolis, Ind.
C. M. BLAIR, Tidioute, Pa. W. S. MALONE, Lisbon, Ohio.
A. StC. DUNSTAN, Auburn, Ala. J. D. HOLDERMAN, Somerset, Ky.
WILLIAM MARTIN, 10 Barclay Street.



NOTE THE CONSTRUCTION.

Use Black Squadron Four Wedge Ring Packing

and the results will surprise you. It will outwear, outlast and keep things in better shape than any self adjusting or other packing on the market.

READ THIS:—

"I beg to advise you that the sample of BLACK SQUADRON PACKING, submitted for trial by the Department of this Depot, has been given a thorough test, with the result that it has proved to be a high grade packing, with a minimum friction, good lubrication and first class lasting qualities. Its construction is such that it has a good expansion, and is, therefore, good on fluted or shouldered end, and is equally satisfactory on water and steam.

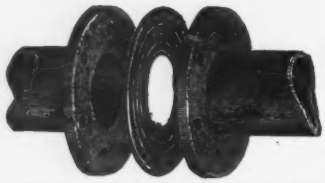
Very truly yours,
G. S. BINGHAM,
Major and Quartermaster U. S. Army.
Depot Quartermaster.

Now send in your name and business address and receive an ENGINEER'S MEMO BOOK and a supply of BLACK SQUADRON **FREE** Express Paid. Supply of Books is limited send in at once to be sure of receiving a copy.

CANCOS MANUFACTURING CO.
146 N. Second Street PHILADELPHIA, PA.

OUR PATENTED MINERAL WOOL

PIPE COVERING



AND

Copper Gaskets

They Save Steam and Make Absolutely Tight Joints

United States Mineral Wool Co.

143 LIBERTY STREET, NEV YORK

BEST AND CHEAPEST SAMPLES FREE

THE BEST RUBBER VALVES AND DISCS

HARD— for Hot Water, Oil and AIR Pumps.

MEDIUM— for Steam and WATER

SOFT— for Cold Water.

Do not BREAK, CHIP or SEPARATE

Resist high TEMPERATURE

DURABLE

SAYEN & SCHULTZ

OXIDIZED RUBBER WORKS

13th and Commerce Sts. PHILADELPHIA, PA.

Our pretty ornamental metal sign, reproduced below, will be found in the warehouses of all the first class jobbers of engineers' supplies in the United States.

Genuine

Detroit SIGHT FEED Lubricators

SOLD HERE

The Detroit Lubricator Co., Makers.
Detroit, Mich., U.S.A.

Buy only genuine goods. Avoid counterfeits.
Catalogue on application.

DETROIT LUBRICATOR CO.

DETROIT. MICH.

STEAM FITTING

if not properly done, in any plant, will cause the engineer a great deal of trouble, and his employer unnecessary expense. Many years of practical experience and a force of competent assistants enables me to guarantee absolute satisfaction.

WILLIAM MILLIGAN, Shop, 726 Sansom Street, Philadelphia, Pa.
'Phones: Bell-Walnut 1271 a, Keystone-Main 1-71 JOBBING A SPECIALTY

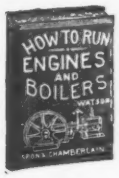
CRANE FITTINGS
ESTABLISHED 1855

PATENTS

promptly obtained **OR NO FEE.** Trade-Marks, Caveats, Copyrights and Labels registered. **TWENTY YEARS' PRACTICE.** Highest references. Send model, sketch or photo. for free report on patentability. All business confidential. **HAND-BOOK FREE.** Explains everything. Tells How to Obtain and Sell Patents, What Inventions Will Pay, How to Get a Partner, explains best mechanical movements, and contains 300 other subjects of importance to inventors. *Address,*

H. B. WILLSON & CO. Patent Attorneys
785 F Street, N. W., WASHINGTON, D. C.

BOOKS
FOR EVERY DAY USE
In the Engine Room



How to run Engines and Boilers

A book full of helpful information for firemen and engineers.
It tells what you want to know in a plain practical way that sticks.

By mail $1.00

A set of 6 large plates to detail with descriptive matter of a high speed steam engine and centrifugal governor. 50 Cents.

Explained simply and clearly. Brought up to the latest American practices. You can use it.

By mail $1.00

SPON & CHAMBERLAIN
Publishers of Books for Engineers
Dept. P. E., Liberty Bldg., **New York, U.S.A.**

Something that will Interest You on Page 48

RED SEAL BOILER COMPOUND

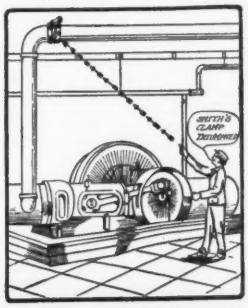
Agents Wanted Everywhere
WRITE FOR TERMS

THE CHERRY CHEMICAL COMPANY
MANUFACTURERS
Office; 1215 Filbert Street, - Philadelphia, Pa.
Circulars, Prices and Directions Furnished on Application

REGISTERED TRADE MARK

Smith's Clamp
For Stopping Leaks in Pipe Joints. It is simple, cheap and sure to stop the leak. Made in all sizes, brass or steel.
Send for circular.
Also Grate Bars and Special Castings.

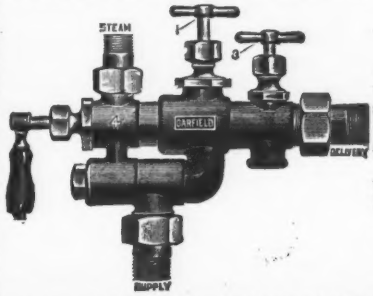
W. Clifford Smith
138 N. Sixth St. PHILADELPHIA



The LAGONDA Tube Cutter

Here's a Money Saver for You.

Cuts any size tube at any point without leaving any burr.
Get a Catalogue of Tube Cutters, Damper Regulators, &c.
THE LAGONDA MFG. CO. **Springfield, Ohio**

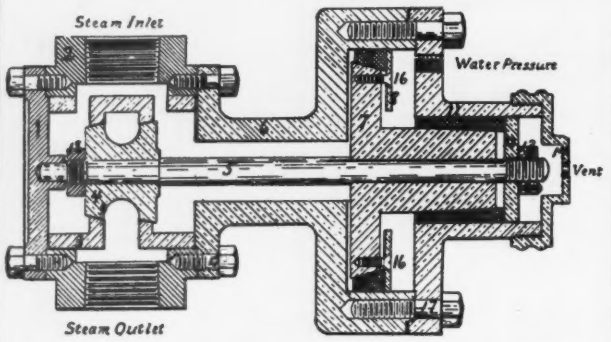


THE GARFIELD
DOUBLE JET INJECTOR

starts at 15 lbs., lifts 25 ft. and works hot water up to 150 degrees under proper conditions. All are made extra strong and heavy and of the best material, thus insuring long life and small cost for repairs.

No power plant is complete without it. See that your boiler is equipped with a GARFIELD INJECTOR. Send for catalogue.

The Ohio Injector Company
WADSWORTH, OHIO



Mullin's Automatic Controller for Boiler Feed Pumps

Delivers more water to boilers when steam-pressure is high, and less when it is low, which not only holds the water uniform, but also tends to hold steam-pressure uniform, saving fuel that is wasted in pumping too fast and flooding boilers when fires are low. It will outlive any pump, and increase the life of the pump one-half.

WRITE US FOR DETAILS

THE FEDERAL VALVE CO.
2534 Western Avenue SEATTLE, WASH.

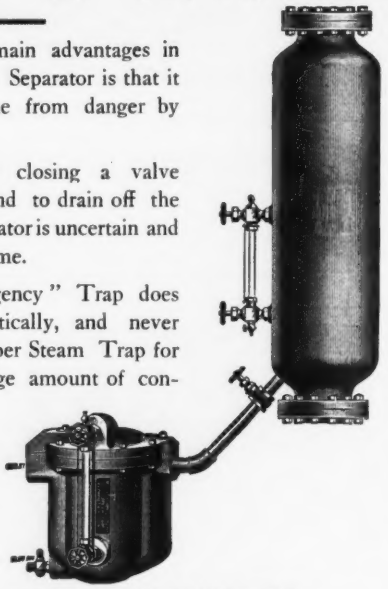
The WRIGHT "Emergency" High Pressure STEAM TRAP

FOR USE ON SEPARATORS

One of the main advantages in using a live Steam Separator is that it protects the engine from danger by water.

Opening and closing a valve occasionally by hand to drain off the water from a Separator is uncertain and risky, and bothersome.

The "Emergency" Trap does this work automatically, and never forgets. The proper Steam Trap for all uses where large amount of condensation must be disposed of instantly, without waste of steam.



ASK FOR PARTICULARS

WRIGHT MANUFACTURING CO.
72 Woodbridge Street DETROIT, MICH., U. S. A.

Everyone knows

that Automobile Tires are made of the finest grade of Para Rubber. We have been using the Scrap or Waste from these tires to make a special grade of fine

SHEET GUM

"Auto" Packing

20 cents per pound

For hydraulic and low pressure steam joints, gaskets, etc. It is press cured material, natural gray rubber color, cloth insertion, all thicknesses. Why pay 50 cents per pound for fancy packing? Send for sample.

SAŸEN & SCHULTZ
MECHANICAL RUBBER WORKS
13th & Commerce Streets
PHILADELPHIA, PA.

A GOOD BOOK

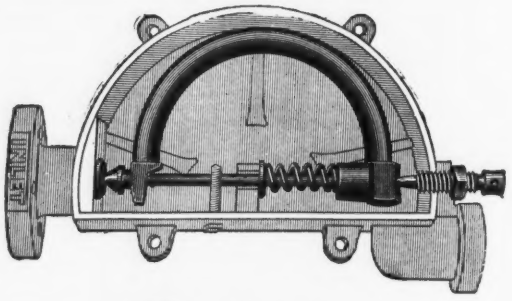
ENGINEERING PRACTICE AND THEORY

This is an instruction book for engineers in charge of steam plants. It is practical and in comprehensive language. It covers the whole field of steam engineering practice and it also contains 200 questions such as an engineer is likely to be asked when being examined for license.

Size five by seven and a half. 184 pages. Price $1.00. Postage paid to any address. Third edition now ready. Write for a copy today.

W. H. WAKEMAN
64 HENRY STREET NEW HAVEN, CONN.

Descriptive Circular will be sent upon request.



Heintz Steam Savers

When properly installed—and we furnish plans and instructions without charge—the Heintz will save at the coal pile, its cost several times a year, besides increasing greatly the efficiency of any heating system or steam controlled apparatus to which it may be attached.

Reliable, accurate, durable, no floats, no complications, just results. Guaranteed or no pay.

WRITE FOR BOOKLET "4"

William S. Haines Co.
136 SOUTH FOURTH STREET. PHILADELPHIA

Pacific Coast Agents, California Engineering and Construction Co.
RIALTO BUILDING, SAN FRANCISCO, CAL.

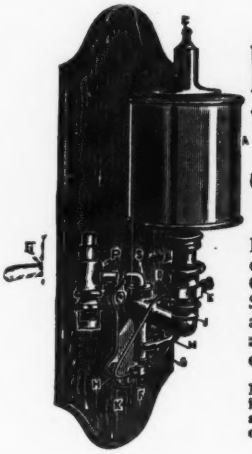
Distributing Agents

John S. Latta & Co., Phila. Oil Well Supply Co., Bradfo . Pa
Aumen Machinery & Supply Co., Baltimore.
PittsburgGage&SupplyCo.Pittsburgh. Industrial SupplyCo.Wilmington

THE CARR PUMP GOVERNOR

Superior to any pump governor on the market "why" Because the cylinder will not LIME, Prevents the pump from RACING in case of a bursted main or hose, Fitted with Renewable Compensating Valve and Seats, Regulation perfect. Especially adopted for Fire and Water Works Pumps, Send for catalogue, 30 days trial.

E. M. CARR,
NEW CASTLE, IND., U. S. A.



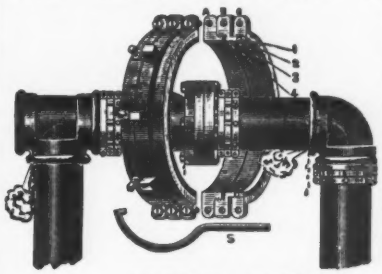
IMPROVED
Kellam Damper Regulators

The Simplest and Closest Damper Regulator.
Manufactured by
J.E.Lonergan&Co.
211 RACE ST., PHILA., PA.

Brass Founders and Finishers and Makers of Pop Safety Valves, Water Relief Valves, Oil Cups and Lubricators, Steam Pressure Regulators and other safety steam appliances.

Old Kellam Regulators Repaired. Correspondence Solicited. Mention this paper if your inquiry is prompted by the sight of this advertisement. Catalogue D free on application.

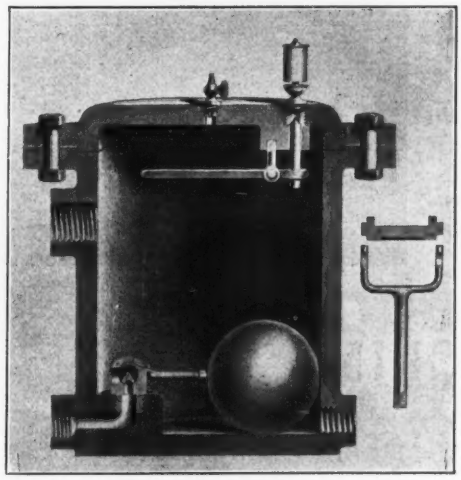
THE CLIMAX STEAM JOINT CLAMPS



has been on the market for seven years, and has stopped many thousands of leaks at pipe joints. Some dealer in nearly every city carries all sizes in stock.

Manufactured by
JAMES McCREA & CO.
67 W. Washington Street, CHICAGO

ENGINEERS SEE FREE OFFER



SEND FOR BOOKLET, C.

PACIFIC COAST AGENTS
MADISON MERCANTILE CO.,
San Francisco, Cal.

Now is the time to look after your Steam Heating System, get a good reliable Steam Trap and be through with Repairing Traps again the coming winter.

THE LINDSTROMS, CORLISS VALVE STEAM TRAP WILL GIVE YOU REST, AND KEEP THE WATER OUT OF THE PIPES WITHOUT WAISTING ANY STEAM.

FREE

A Blue Print Showing how to Set Valves on Corliss Engines Simple and Compound with One and Two Eccentrics FREE with every Steam Trap Order.

CYLINDERS REBORED

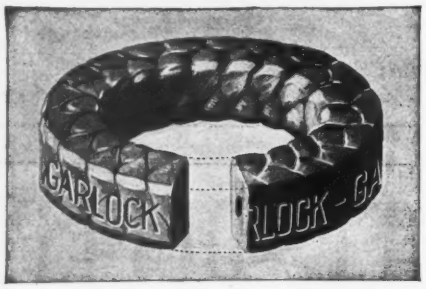
Expert Machinists sent to all parts of the country with Special Portable Tools to Rebore Cylinders in their present position from 4 inches to 80 inches in Diameter, No matter what the trouble is with your Engine or Pumps we can help you.

JOHN T. LINDSTROM
214-216 S. Third Street ALLENTOWN, PA.

The Garlock Trade Mark on Packings, Hose, and Mechanical Rubber Goods is a Symbol of Reliability, Efficiency and economy.

AS ENGINEERS are deeply interested in goods of merit that enter into operation of their plants, we present in the following two Garlock Products which are absolutely Reliable, Efficient and Economical, and stand without an equal in the world.

This is a broad statement to make, but our experience of the last twenty-five years, and the results of tests made in the largest power plants in the world, which have adopted our goods, warrant the assertion. We invite the hardest and the fullest investigation of their merits.



No. 99.

Garlock Waterproof Hydraulic Packing for Hydraulic Pressure

up to 20,000 pounds per square inch on Lifts, Accumulators, Hydraulic Cranes, Elevators, Pump Plungers, and all forms of Hydraulic work.

The enormous sales of this packing attest the high favor in which it is held by mechanical engineers.

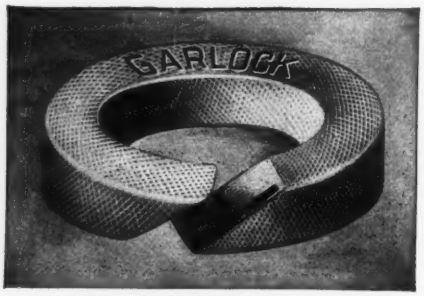
Garlock High Pressure Packing

RING, SPIRAL OR COIL

is the only fibrous packing that gives entire satisfaction on high speed and marine engines, locomotives, rods running in oil, grease or chemicals.

Excels every other packing for expansion joints.

One of the best proofs that we have the only successful High Pressure Packing on the market is that it is imitated by every important manufacturer of packing in the world, but has never been equalled.



No. 200.

THE GARLOCK PACKING CO.

Main Office: Palmyra, N. Y., U. S. A.

FACTORIES

PALMYRA, N. Y. SAN FRANCISCO, CAL. ATLANTA, GA.
DENVER, COLO. HAMBURG, GERMANY

STORES

Philadelphia Chicago St. Louis Palmyra, N. Y.
New York Pittsburg Atlanta, Ga, San Francisco
Boston Cleveland Denver Hamburg, Germany

Positively Your Last Chance

If you want one of those inch and metric foot rules, you must act at once—now, as this is the last time the offer will appear. It costs you nothing. We make you a present of one merely to get acquainted. Just send us a sample of scale from your boiler and the coupon, and we will send you the rule by return mail. We will also send you some valuable information on freeing your boiler from scale and keeping it free. We want the opportunity of proving that there is only one way of doing this and that is by the use of

Lord's Boiler Compounds

Send sample of scale and coupon today

The Geo. W. Lord Co.
2238-50 N. 9th Street,
Philadelphia, Pa.

Gentlemen: I am sending you a sample of scale from our boiler. You are to analyze it, and send me, free of charge, a certificate of analysis and the inch and metric foot rule.

Number of boilers in use _____
Capacity of each boiler _____
Frequency of cleaning boilers _____
Frequency of opening the blow-off during working hours _____ *River or other source of water supply* _____
Boilers are used about _____ *hours out of 24*
Boiler compound now used _____
Name _____
Street and Number _____
City _____ *State* _____
Firm's Name _____
Pract. Eng. *Date* _____ *1904.*

The Practical Engineer's Favorites

The Patterson-Berryman Feed Water Heater and Purifier

IMPROVED TO DATE

By means of exhaust steam from the engine, it supplies pure hot water for boilers (or other purposes) at 200 degrees F. or above, saving fuel which would otherwise be used in heating the water to that temperature.
This means a reduction of from 10 to 20 per cent. of the coal bill.

PATTERSON BELT PUMPS

Every engineer knows how extravagantly steam pumps use steam. The power required for a Belt Pump would hardly be missed. And it is not necessary to buy one of the expensive kind. Ours is simple, strong and fully guaranteed.

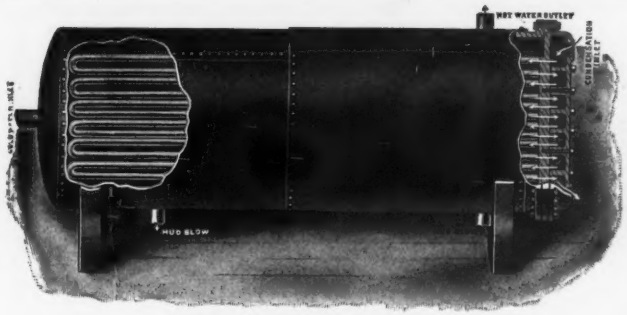
PATTERSON EXHAUST HEADS

Are you tired of having that exhaust pipe spattering greasy spray over the roof, walls, walks and your clothes? Possibly the neighbors are too.
Wouldn't it be better if the vapor floated away *dry and noiselessly?*

WRITE FOR CATALOGUE

FRANK L. PATTERSON & CO.

24 CORTLANDT STREET **MANUFACTURERS** **NEW YORK**



The Gleaner

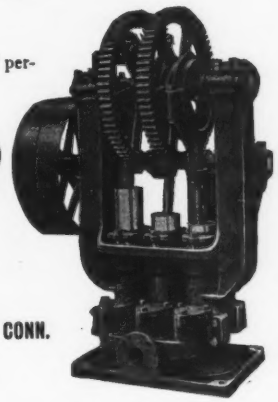
TRADE MARK

The **Gleaner** represents the acme of perfection in feed water heating.

THE

Davis Triplex Power Pump

is a perfect type of the vertical triplex belt driven pump.



MANUFACTURERS OF

The "Berryman" Feed Water Heater and Purifier.

I. B. DAVIS & SON, HARTFORD, CONN.

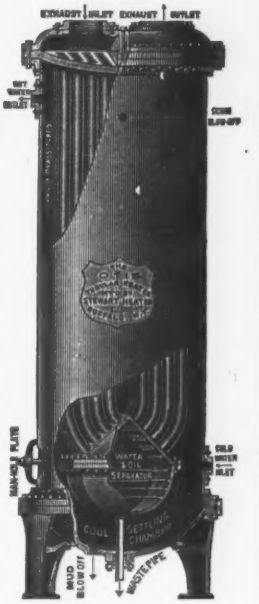
WRITE FOR CATALOGUE, ETC., TO

THOS. McADOO, 125 N. 4th St., Philadelphia

THE **OTIS** Tubular Feed

WATER HEATER, OIL SEPARATOR and PURIFIER

with Seamless Brass Tubes



Guaranteed

To heat the feed water to the boiling point (210 or 212 degrees) with the exhaust steam without causing any back pressure, **also to extract the oil from the exhaust,** so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the additional expense of an eliminator.

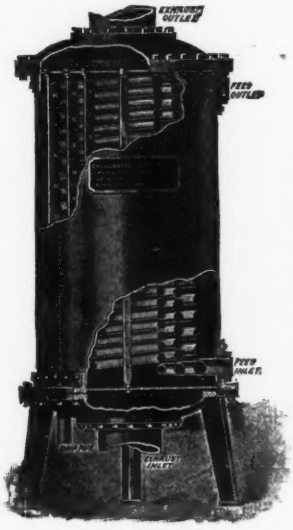
A Liberal Offer

If this heater fails to give satisfaction in every respect, we pay freight, cartage, etc., both ways.

The Stewart Heater Co.

11 Norfolk Avenue, Buffalo, N. Y., U. S. A.

THE AMERICAN STANDARD COPPER COIL FEED WATER HEATER



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for three years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

That's the kind of a Heater you want.

Write for Catalogue No. 100 P

The Whitlock Coil Pipe Co.

HARTFORD : CONNECTICUT

Size vs. Saving

Bulk is not everything. Even the builders who claim to make "the biggest heater for the money" don't always employ the doctor who gives the largest doses.

WEBSTER
FEED-WATER HEATERS
AND PURIFIERS

will often do far more work than heaters that fill far more space.

Compare efficiency, not size. Size is what you pay rent for.

Write for Booklet F 13.

WARREN WEBSTER & Co.
CAMDEN, N. J.

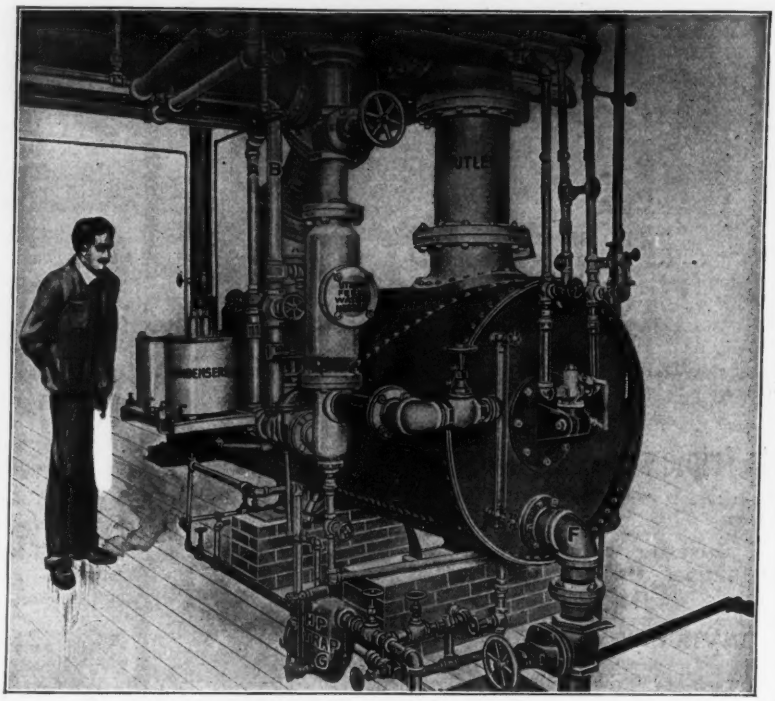
Utility

EXHAUST MUFFLER, OIL SEPARATOR, RETURN TANK, PUMP GOVERNOR AND FEED WATER HEATER

HERE'S THE WAY WE PROVE OUR CLAIM.

See those two condensers just in front of the man? We condense the steam before and after it passes through the separator of our "UTILITY" COMBINATION and submit the samples for analysis just as they are drawn.

There isn't another separator manufacturer in the world that would dare do that with a separator that has been in use any length of time, but we leave the condensers on permanently if desired and after years of use the elimination of oil is as complete as in a new apparatus.



The "Utility" Combination

Serves as exhaust muffler, oil separator, return tank, pump governor, and feed water heater. It costs only about as much as a feed water heater, and heats the feed water to about the same temperature as the exhaust steam.

We mention a few of the late and up-to-date plants that have adopted the "Utility" Combination

R. H. MACY & CO.,	3,000 H. P.	HOTEL BELMONT,	2,000 H. P.
METROPOLITAN LIFE INS. CO.,	1,900 "	MUSEUM OF NAT. HISTORY,	1,800 "
METROPOLITAN LIFE INS. CO.,	700 "	MANHATTAN LIFE INS. CO.,	1,000 "
PRUDENTIAL LIFE INS. CO.,	2,500 "	MET. MUSEUM OF ART,	1,000 "
MUTUAL LIFE INS. CO.,	1,000 "	MET. MUSEUM OF ART,	850 "
MUTUAL LIFE INS. CO.,	700 "	WALL STREET EXCHANGE,	1,200 "
MUTUAL LIFE INS. CO.,	400 "	WHITEHALL BUILDING,	1,000 "

HOTEL IMPERIAL,	1,000 "
MARTINIQUE APARTMENTS,	1,000 "
BLOOMINGDALE BROS.,	1,000 "
PERRY PAYNE CO.,	1,000 "
TRINITY CORP. W. BLDG.,	1,000 "
WASHBURN WIRE CO.,	1,000 "
MERCHANT'S REFRIG. CO.,	800 "
MERCHANT'S REFRIG. CO.,	500 "
MERCHANT'S REFRIG. CO.,	350 "
CENTRAL BREWING CO.,	1,000 "

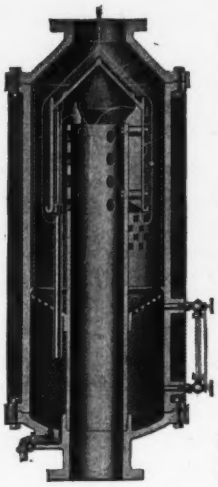
Why was the "Utility" selected for these and many other steam plants? Because we have proven by chemical tests that our system according to horse power saves thousands of dollars per year in running expenses. We can do the same for you.

"Utility" Pump Governor Best Pump Governor on the market because the Valve will not leak or stick. We guarantee it to absolutely govern the pump and remain tight for five years.

THE STANDARD STEAM SPECIALTY CO., 542-544 W. Broadway, CITY OF NEW YORK. "Utility" Steam Specialties.

PHILADELPHIA OFFICE: 341 Bourse Building.

Sweet's Separators



Our steam separators deliver steam containing less than one half of one per cent. of water.

Our oil separators remove 99 per cent. of the oil.

We can prove they do it and give good reasons why.

In addition they have size and are machines.

Made in all styles, also make Exhaust Heads and Steam Traps.

Direct Separator Co.

220 Marcellus Street

Syracuse : : New York

AT THE WORLD'S FAIR

Baum Steam Separators

VACCUM STYLE

STANDARD FORM

Oil Extractor

Protect 6,500 H. P. Engines.

Baum Vacuum Oil Separators

Purify and Exhaust from same Engines

Can be seen in operation, Blocks 45, 46, 50, Machinery Hall. Our Exhibit, Bock 22 Machinery Hall.

Send for catalog.

Horizontal Style for live Steam or Oil Service.

BAUM SEPARATOR & MACHINE CO. MANHEIM, PA.

BERRYMAN

Feed Water Heaters and Purifiers

WATER TUBE AND STEAM TUBE

Cast Iron or Steel Shells. "U" Shaped Seamless Drawn Brass Tubes.

We Build Heaters for Every Purpose and Condition

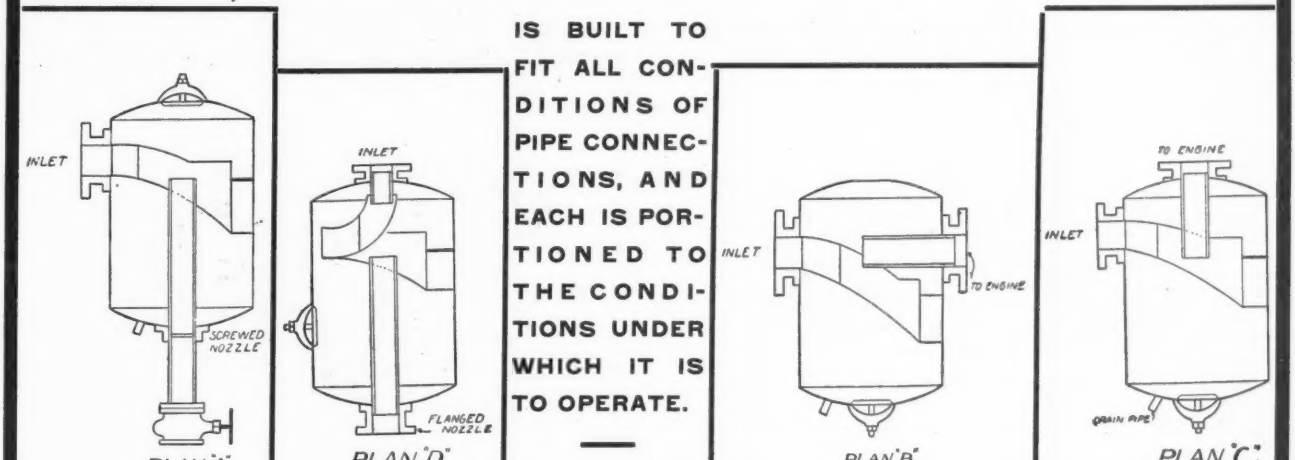
THE KELLEY PATENT

IMPROVED BERRYMAN WATER TUBE FEED WATER HEATER AND PURIFIER

Benj. F. Kelley & Son - Makers

91 Liberty Street, NEW YORK

The Simonds Steam Receiver and Separator



IS BUILT TO FIT ALL CONDITIONS OF PIPE CONNECTIONS, AND EACH IS PORTIONED TO THE CONDITIONS UNDER WHICH IT IS TO OPERATE.

Manufactured By

FRANK A. SIMONDS

421 HOUSEMAN BUILDING GRAND RAPIDS, MICH.

Scale, Foaming and Corrosion

ARE EASILY OVERCOME BY THE

"CCC." Compound

TRY A SAMPLE BARREL

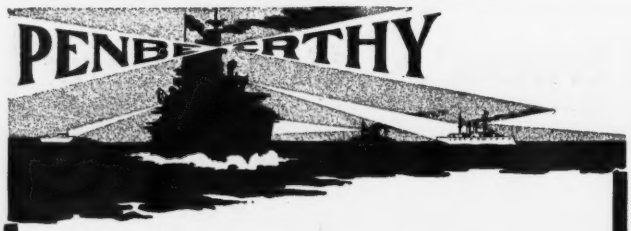
and then see!—see!—see!

No Cure, No Pay—That's our way

Continental Chemical Co.

2923 N. Broad Street PHILADELPHIA

SHIPPED IN STEEL TANKS



WHEN ALL AT SEA

as to the best Boiler Feeder for your plant, pin your faith to

THE PENBERTHY AUTOMATIC INJECTOR.

It can be trusted to give always the same unvarying satisfactory service. Its record for handling hotter water starting at the lowest pressure, and working at highest pressure, has made it a favorite with over 350,000 engineers. Follow their example and get the best.

THE PENBERTHY LOW WATER ALARM

differs from the usual "column" type, and is in every way better and surer. It cannot be stopped by lime or sediment, and has been proven by every test absolutely reliable. Best and costs less.

Every engineer should have our catalog ready for instant reference. Write for it to-day.

Penberthy Injector Co.

344 Holden Avenue,
DETROIT, MICH., U. S. A.

Largest manufacturers of Injectors in the world.

The Penberthy Bulletin sent free for 3 months.

Penberthy Injector Co., Ltd.
Windsor, Ont.

THERE ARE MORE

Compound Separators

used in boilers than all others.

They insure dry steam, and protect your engine from water.

Compound Separator

Boiler Fronts, Grate Bars, Furnace Castings, Compound Separators, and General Boiler Castings

---

The Kutztown Foundry and Machine Co.

WORKS:

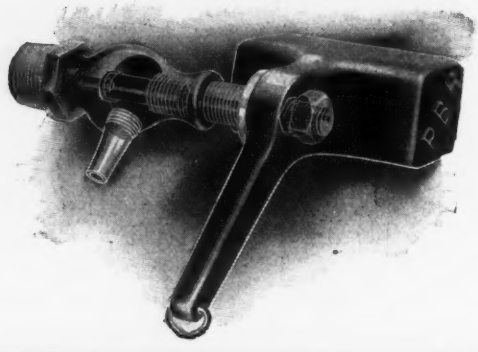
KUTZTOWN, PENNA.

Philadelphia Office: Fidelity Building, Broad above Arch Street.

GET ONE FREE

Put it on your boiler, and give it a good trial for a month; if it gives you absolute satisfaction, keep it, and pay for it, otherwise send it back at our expense.

"P. B. H." WEIGHT GAUGE COCK



There is but ONE renewable part; the special metal valve pencil, which lasts for years and can be replaced for a few cents, in a minutes time. Thousands in use. Absolute satisfaction on high pressures.

Paul B. Huyette, **1245 BETZ BUILDING PHILADELPHIA**

BECAUSE U. S. INJECTORS ARE BEST

the United States Government has adopted them.

Over 200,000 engineers use them.

Buy of the dealer. Get the genuine. Catalogue on request.

Our "Engineer's Red Book" should be in every engineer's pocket. Answers 500 questions of vital importance. FREE. Write for it to-day.

American Injector Co.
DETROIT, MICH., U. S. A.

This Book Free

Send us Three Subscriptions to The Practical Engineer at Fifty Cents each and we will send you Free a copy of

Hand Book of Corliss Steam Engines

BY FRANK WILLIAM SHILLITTO, JR.

This book describes, in a comprehensive manner, the Erection of Steam Engines, the Adjustment of Corliss Valve Gear, and the Care and Management of Corliss Steam Engines. It is illustrated by 64 Original Engravings. 200 Pages.

Price, $1.00, or will be sent Free for a Club of Three Subscribers to The Practical Engineer at 50 cents each.

We also have other books which we give as premiums for clubs of subscribers.

AGENTS WANTED. We want a few good agents to solicit subscriptions for The Practical Engineer on liberal commission basis. Hustlers can make good money. Write for terms, stating qualifications, experience, etc.

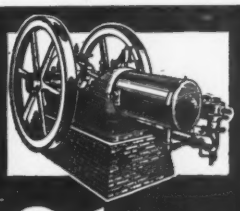
The Practical Engineer is the largest and best mechanical journal ever published anywhere in the world for fifty cents a year, and getting subscriptions for it is just like finding money.

Address Department A.

The Practical Engineer
46 N. TWELFTH ST., PHILADELPHIA, PA.

YOU CAN SAVE
MONEY
BY USING
"STEEL MIXTURE"
BOILER DOOR ARCHES
AND FIRE BOX BLOCKS
TONGUED AND GROOVED

ENQUIRIES SOLICITED
McLEOD & HENRY CO.
TROY, N.Y. U.S.A.



Olds
Gas and Gasoline Engines

are strong and simple in construction. Parts are few and easily understood. Olds engines can be readily operated by any man of ordinary intelligence without previous experience. Repairs, though seldom necessary, can be quickly and economically made.

Stationary Engines, 2 to 100 H. P.
Portable Engines, 8 to 35 H. P.

For complete information and new illustrated catalog, write

OLDS GASOLINE ENGINE WORKS
244 River Street LANSING, MICHIGAN

DEARBORN
Water Treatment For Boilers

Corrects the feed-water you are using.

Dearborn Water Treatment will cause the reduction and removal of the incrustation now in the boilers. It will prevent the formation of new incrustation.

For any boiler waters we undertake to treat, we positively know we can put together preparations that will completely and successfully react with the scaling-salts of the water, converting them into mud of light gravity, easily washed out when boilers are open.

Dearborn Water Treatment is not made for scaling waters alone; it is made and used in hundreds of cases where the water doesn't scale, but causes pitting and corrosion of the boilers; also for waters that prime and foam. Because your boilers do not scale does not indicate that the water you are using does not need correction for injurious action in some other direction. Send gallon sample to our Laboratory at Chicago for analysis. We will send you report and if, by a treatment we would prepare for it, we can make the use of that water more economical for you, we will tell you so.

Remember, if the analysis of the water shows it does not need any treatment, or that it is so bad we could not treat it economically, we will tell you so. Remember further, we are too busy to waste time for a *first order only*. We will be perfectly honest with you and take it that you will be with us by using Dearborn Water Treatment the way we direct on each barrel when you purchase it.

WRITE FOR BOOKLET "N"

DEARBORN DRUG AND CHEMICAL WORKS

WM. H. EDGAR, President
CHAS. M. EDDY, Sec. and Treas.

ROBT. F. CARR, Vice-Pres. and Gen. Mgr.
WM. B. McVICKER, 2d Vice-Pres. and East Mgr.

LABORATORIES AND WORKS, CHICAGO

NEW YORK:
120 Liberty Street

Philadelphia Office: The Bourse

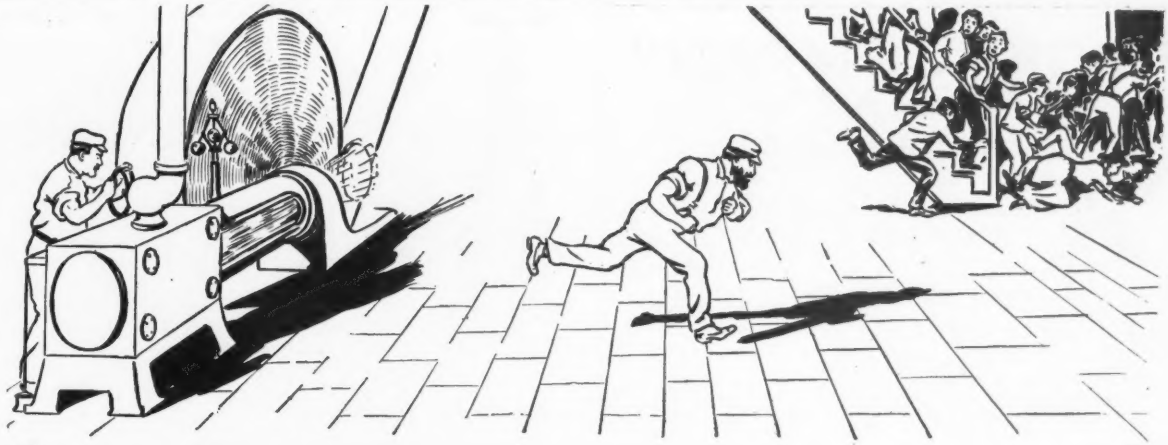
CHICAGO:
27-34 Rialto Building

BRANCH OFFICES

Boston, Oliver Building
Pittsburg, House Building
Buffalo, Ellicott Square Building
Cincinnati, Union Trust Building
Detroit, Majestic Building

Atlanta, Prudential Building
St. Louis, Security Building
Kansas City, New York Life Building
St. Paul, 1237 Lincoln Avenue

Denver, Boston Block
Salt Lake City, Dooly Block
San Francisco, 115 Davis Street
Los Angeles, 307 N. Los Angeles Street
Honolulu, Brewer Block



The Watchful Engineer Risked His Life To Save The Workmen.

The governor "seized" and thus allowed the engine to race. Before the Watchful Engineer could reach the throttle valve the 15-ton flywheel was at bursting point; still he never thought of his own danger; he only thought of the number of workmen who would be killed and injured if the flywheel did burst; so he stood his ground and stopped the engine before any damage was done. The workmen will never forget the Watchful Engineer.

The Watchful Engineer also saves money for his employer and time and trouble for himself by always using

Genuine Eureka Packing

on the engine and pump rods, because experience has taught him that "Eureka" gives the best results; has the longest life; causes the minimum of friction, and is only half the trouble and expense in the long run.

The Watchful Engineer sees that his engine is absolutely protected against water and boiler against oil by having a

Hine Eliminator

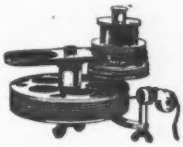
in the steam line near the cylinder. He says the "Hine" takes care of all the condensed steam, and also the flood that sometimes comes along and extracts oil from exhaust steam.

At least once per week the Watchful Engineer indicates the engine with his

Robertson-Thompson Indicator,

which is so easy to apply and operate that it only takes a few minutes to get the cards, and thus he knows that the engine is running with full economy.

The Watchful Engineer never wastes time rigging up complicated reducing motion, he just uses a



Victor Reducing Wheel,

with which he can instantly connect up the indicator without even slowing down the engine, and he always finds the M. E. P. of his diagrams with

The Willis Planimeter,

because it is the simplest, quickest and most accurate one made, all or either of these three instruments can be had on very easy terms where satisfactory references are furnished.

OUR CATALOG IS FOR ENGINEERS. HAVE YOU GOT YOURS?

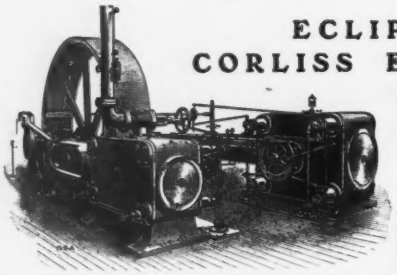
James L. Robertson & Sons,

205 FULTON STREET **NEW YORK, U. S. A.**

FRICK COMPANY

ENGINEERS

WAYNESBORO, FRANKLIN CO., PA.

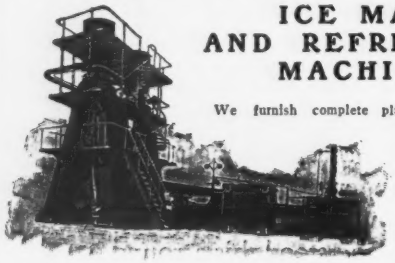


ECLIPSE CORLISS ENGINES

Plain Corliss Engines, Cross and Tandem Compound, Vertical Corliss Engines.

Corliss Engines of any type, 40 to 2000 horse power, specially adapted for electric railway work and lighting for factories, mills and general work.

Best regulation and economy guaranteed. Also builders of Steam Boilers. We solicit the furnishing of steam plants complete, including everything. Send for our CORLISS ENGINE PAMPHLET and list of references.



ICE MAKING AND REFRIGERATING MACHINERY

We furnish complete plants for ice-making and refrigeration for Breweries, Packing Houses, Cold Storage, etc. All refrigerating capacities from 2 to 300 tons; ice-making plants from 1 to 1000 tons per day. We publish a book describing Ice-Making and Refrigeration, which will be sent to intending purchasers.

NEW YORK OFFICE: Taylor Bldg., 39-41 Cortlandt Street

This will interest Engineers in charge of Pneumatic Elevators Plants.

THE BUFFALO AIR INJECTOR

is the latest and best device for compressing air in connection with a common water pump for Pneumatic Elevator Plants. For simplicity, beauty and work, it is unequalled.

See your elevator company, or write for illustrated catalogue. The Buffalo Air Injector is manufactured by

JOHN G. STAMP, *Chief Engineer*

202 Main Street :: BUFFALO, NEW YORK

ELECTRIC, HYDRAULIC, STEAM BELT AND HAND POWER

ELEVATORS

FOR

PASSENGERS and FREIGHT

INSTALLED OR REPAIRED

Parts for all kinds of Elevators carried in stock.
Repairing done on shortest notice.

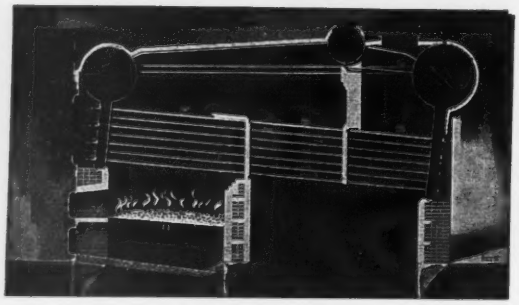
Keystone Elevator Inspection and Repair Co.

923 Locust Street. PHILADELPHIA.

ESTIMATES ON NEW WORK

BOTH PHONES

ATLAS



ENGINES AND BOILERS

CORLISS	WATER-TUBE
FOUR-VALVE	HIGH PRESSURE TUBULAR
SINGLE-VALVE	STANDARD PRESSURE TUBULAR
AUTOMATIC	INTERNAL FIRED
THROTTLING	LOCOMOTIVE TYPE

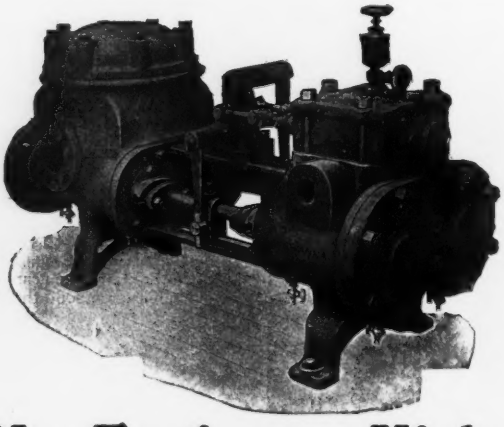
For Immediate Delivery

ONE 18 x 34 x 42 R. H. HEAVY-DUTY CORLISS
ONE 15 x 28 x 42 R. H. HEAVY-DUTY CORLISS

(These are new engines, never out of the shop.)

Atlas Engine Works.
Indianapolis.

For prompt attention address Dep't P.



No Engineer Kicks

BECAUSE HIS

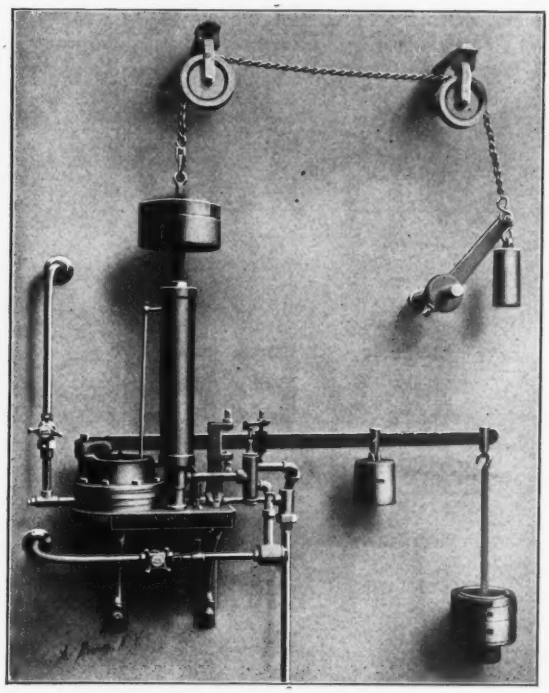
Pump Won't Work

Our pumps won't kick—can't kick. The guided cross head and the fact that stuffing boxes can be replaced by loosening two stud nuts are two features. Many more are mentioned in our new catalog. Write for it to-day, and before deciding on any pump investigate this one.

Lackawanna Pump Works

(Specialists in Boiler Feed Pumps)

Walnut St. & Capouse Ave. SCRANTON, PA.



$50.00

FOR No. 3.

PATTERSON (PERFECTED) GRADUATED SCALE BEAM REGULATOR

Best and Cheapest Hydraulic Damper Regulator in the world.

Scientiffically Designed-Simple in Construction.

Will handle 1 to 20 Dampers on (1) pound variation.

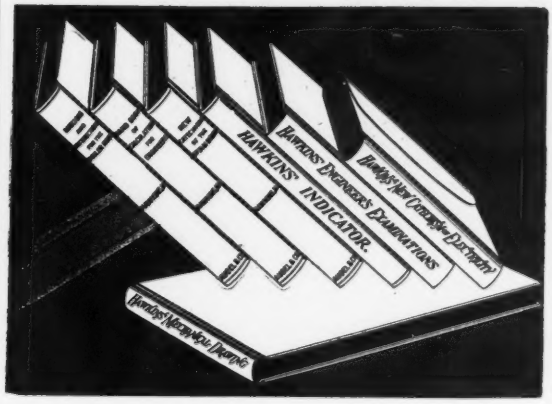
Sent anywhere on 30 days trial,
Satisfaction guaranteed or no pay.

Any "Supply House or Steam Fitter," would furnish the Patterson (up-to-date) Regulator.

PATTERSON MANUFACTURING CO.

No. 301 N. Holliday Street, - - BALTIMORE, U. S. A.

ENGINEERS' STANDARD LIBRARY



CUT OUT AND MAIL TO-DAY

I accept your offer to supply me with HAWKIN'S ENGINEERS' LIBRARY (seven volumes) for $12. Enclosed find $1 as first payment; the balance I agree to remit in $1 monthly installments.

Name_____ Occupation _____

Address _____

—— You are at Liberty to consult the person named below as to my reputation for keeping business promises.

Name_____ Occupation _____

Address _____

P. E.

To Readers of Practical Engineer

The seven volumes, which comprise the author's complete works, are supplied to responsible parties on the one dollar monthly payment plan; the complete library is delivered to the subscriber, express or post prepaid, upon receipt of the first payment of one dollar, the balance to be sent one dollar monthly to the publishers, by post-office or express money order.

The Hawkins' Works are kept constantly "up to the times" by frequent revisions and additions by the author; to this fact is undoubtedly largely due their continued popularity.

LIST

Hawkins' Self-Help Mechanical Drawing.	$2
Hawkins' New Catechism of Electricity,	2
Hawkins' Aids to Engineers' Examinations,	2
Hawkins' Maxims and Instructions for the Boiler Room,	2
Hawkins' Hand Book of Calculations for Engineers,	2
Hawkins' New Catechism of the Steam Engine,	2
Hawkins' Indicator Catechism (a Practical Treatise),	1

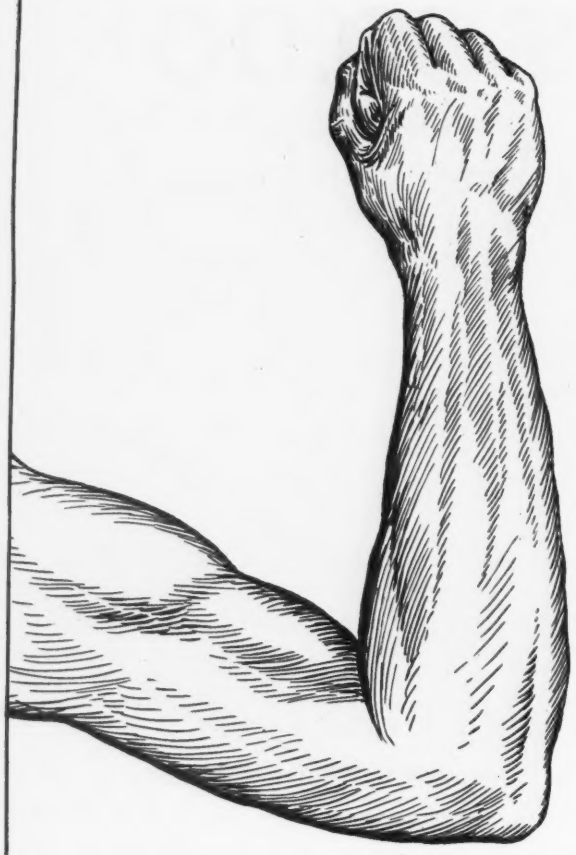
When set is purchased, the seven volumes are supplied for $12.00, being a reduction of $1.00 from above list.

. . SEND POSTAL FOR CATALOG . .

THEO. AUDEL & COMPANY

EDUCATIONAL BOOK PUBLISHERS

63 FIFTH AVENUE, NEW YORK CITY



DID IT EVER STRIKE YOU

that we're still in the Pipe Covering Business?

Perhaps we can tell you something that you want to know about Pipe and Boiler Coverings.

WRITE FOR CATALOG AND PRICES

NORRISTOWN COVERING CO.
NORRISTOWN, PA.

KEYSTONE PHONE—263 BELL PHONE—137-A

BRANCHES

BOSTON NEW YORK PHILADELPHIA BALTIMORE

KEYSTONE GREASE —

NOTHING BETTER!

Because of it's purity, consistency and tremendous heat resisting properties, one pound of

KEYSTONE GREASE

will do better work and last longer than four gallons of high grade lubricating oil or from three to five pounds of any other grease made.

KEYSTONE GREASE is always uniform in quality, it never changes, temperature does not affect it, neither does time change it. It is always absolutely certain to give results on any kind of bearings to which it is applied.

To show what KEYSTONE GREASE will do, we will send

FREE

EXPRESS PAID to any engineer sending us his name and business address a large sample can of KEYSTONE GREASE and a heavy well finished brass grease cup.

We are independent manufacturers. No connection with oil trusts.

KEYSTONE LUBRICATING CO.
20th and Allegheny Avenue,
PHILADELPHIA, PENNA.

In sending name, please state size of tap — also horse power and where it is intended to use grease so that we can send the proper cup

GAS, GASOLINE AND OIL ENGINES

By GARDNER D. HISCOX, M. E.

Tenth Edition, Revised and Much Enlarged

The best American book on this subject, and a book designed for the general information of every one interested in this new and popular motive power.
This book treats of the theory and practice of Gas, Gasoline, and Oil Engines, as designed and manufactured in the United States. It also contains chapters on Horseless Vehicles, Electric Lighting, Marine Propulsion, etc.

Large Octavo. Illustrated by 312 Engravings. 396 Pages.

Price, $2.50, or will be sent free for a club of eight subscribers to THE PRACTICAL ENGINEER at 50 cents each.

MECHANICAL REFRIGERATION AND ICE-MAKING AS IT IS TO-DAY JUST PUBLISHED

PRINCIPLES AND PRACTICE

OF

Artificial Ice-Making and Refrigeration

Comprising: Principles and General Consideration; Practice as Shown by Particular Systems and Apparatus; Insulation of Cold Storage and Ice Houses, Refrigerators, etc.; Useful Information and Tables.

By LOUIS M. SCHMIDT

Second Edition, Revised and Enlarged

Illustrated by One Hundred and Fifty-three Engravings. xvi+291 Pages, 8vo.

Price, $2.50, or will be sent free, as premium, for a club of eight subscribers to THE PRACTICAL ENGINEER, at 50 cents each.

HAND-BOOK OF

CORLISS STEAM ENGINES

Describing, in a comprehensive manner, the Erection of Steam Engines, the Adjustment of Corliss Valve Gear and the Care and Management of Corliss Steam Engines.

By FRANK WILLIAM SHILLITTO, JR.

Illustrated by 64 Original Engravings. 200 Pages.

Price, $1.00, or will be sent free for a club of three subscribers to THE PRACTICAL ENGINEER, at 50 cents each.

THE PRACTICAL MANAGEMENT

OF

DYNAMOS AND MOTORS

By FRANCIS B. CROCKER and SCHUYLER S. WHEELER, D. Sc.

WITH A SPECIAL CHAPTER BY H. A. FOSTER

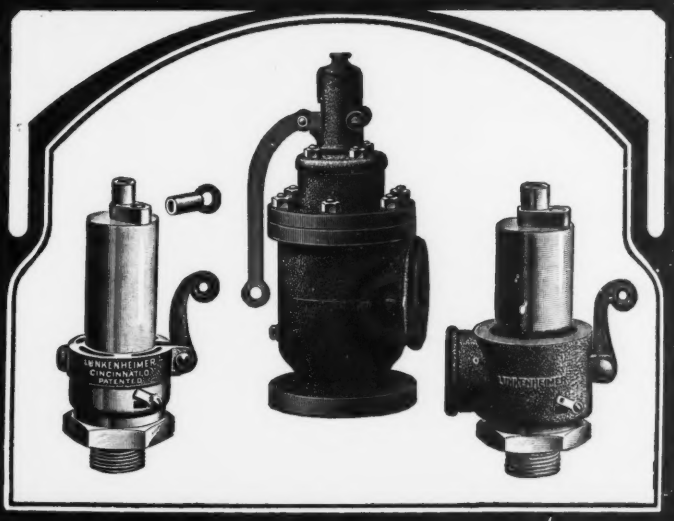
This book treats upon the Principles of Dynamos and Motors, and their General Care and Management. It is an excellent little volume, and is worth many times its cost.

12 mo., Cloth. 210 Pages. 100 Illustrations.

Price, $100, or will be sent free for a club of three subscribers to THE PRACTICAL ENGINEER, at 50 cents each.

Address, THE PRACTICAL ENGINEER, 46 North Twelfth Street, Philadelphia.

LUNKENHEIMER



FOR STATIONARY PORTABLE & MARINE
STEAM BOILERS

Insure against boiler explosions by providing a Lunkenheimer Pop Safety Valve for your boiler. Lunkenheimer Valves are made of the very best materials and workmanship, have liberal springs, full relieving capacity and are always prompt and reliable in operation. Subjected to rigid test and inspection and warranted to satisfy. Specify *Lunkenheimer* and order from your dealer. Write for catalog.

The Lunkenheimer Company,

Largest Manufacturers of
Engineering Specialties in the World,

CINCINNATI, OHIO, U. S. A.

Branches { New York, 26 Cortlandt St.
{ London, 35 Great Dover St.

POP SAFETY VALVES

6

Sales Agents for Philadelphia and Vicinity: FORD & KENDIG CO., Nos. 1428-1432 Callowhill Street.
Engineers and others interested are invited to call and inspect a full line of Lukenheimer Specialties.

NONPAREIL CORK

PIPE COVERING

SHEET CORK For Cold Storage Insulation

—ALSO—

ASBESTOS and Air Cell COVERING

John R. Livezey
1936 Sansom Street
PHILADELPHIA

AGENCIES
BALTIMORE
WASHINGTON
CHICAGO

The Nonpareil Cork Works
80 Hudson Street NEW YORK

JENKINS BROS. VALVES

are the original Renewable Disc Valves, and are unquestionably the best for steady every day service, for no matter what may be the conditions, they always prove to be durable, giving the most perfect satisfaction with minimum amount of attention and repair. The manufacturers of Jenkins Bros. Valves have one aim constantly in view—that of giving the user the best valve that can be produced, regardless of expense. It is their specialty, and they use every precaution to have their valves as near perfection as possible. Hence, every Jenkins Bros. Valve is sold under the positive guarantee that if it is not perfectly tight, or does not hold steam, oils, acids, water, or other fluids longer than any other valve, it may be returned, and money will be refunded.

Is it possible to make a fairer offer?

As there are numerous imitations, in order to obtain the genuine it is necessary to specify "Jenkins Bros." Valves, and see that they bear our name and Trade Mark, as shown in cut.

Send for a copy of our booklet—
"VALVE TROUBLES. AND HOW TO AVOID THEM."

JENKINS BROS.

71 John Street, NEW YORK — 133-137 N. Seventh Street, PHILADELPHIA
31-33 N. Canal Street, CHICAGO — 35 High Street, BOSTON
62 Watling Street, Queen Victoria Street, LONDON, E. C., ENGLAND